THE PROCEEDINGS

OF THE

UNITED STATES NAVAL INSTITUTE.

Vol. XVI., No. 2. 1890. Whole No. 53.

U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

REPORT OF POLICY BOARD.

NAVY DEPARTMENT,
WASHINGTON, *January* 20, 1890.

Sir: In submitting a report under your instructions of July 16, it is deemed necessary in the beginning to state clearly, as they appear to the Board, the considerations demanding the maintenance of a strong naval force by the United States. Thence the limits of a sufficient force may be evaluated, and its different elements determined with reference to the services shown to be required of it.

It need not be pointed out that there are several ways of approaching this subject, and especially of estimating in gross the magnitude of the force required. The following argument, besides covering the broad questions, defines the duties of the more important types and supplies certain of their controlling features.

It may be stated that a navy is essential (1) for waging war and (2) to prevent war; and the second purpose may be far more important than the first. The Board in making this statement does not overlook the many important duties which a navy has to perform in time of peace, but a navy which is adjusted to meet the requirements of the country in time of war will, undoubtedly, be ample to perform the duty required of it in time of peace; and it may be rigidly accepted that there is no real ultimate economy in the maintenance

of vessels apparently adapted to the more economical performance of the latter duty, if ill adapted to the former. The magnitude of the naval force to be maintained by a government should be adjusted on the one hand to the chances of war, and the magnitude of the naval force which a war would bring against it; and, on the other hand, it should be commensurate with the wealth of the country and the interests at stake in case of war. If the chances of war are slight, and the interests to be guarded are unimportant, certainly the naval force to be maintained need not be great; if the chances of war are great, then the naval force which should be maintained ought to be limited by nothing but the limits of the nation's wealth; for, in case of war, its life is at stake. Whatever may be the chances of war, if the interests to be guarded are great, then the naval force to be maintained should also be great.

In these cases, it is assumed that the protection required is best given by a naval force. For the United States, it may confidently be asserted that the chances of war are much less than for most European nations, or at least that the chances of war with any nation comparable with this in wealth and power are much less than the chances of war among the nations of Europe. The isolated position of this country removes many incentives to war.

We fear no encroachments upon our territory, nor are we tempted at present to encroach upon that of others. Our territory does not obstruct the free passage to the sea of the commerce of any nation, nor is our own obstructed in any similar way. We have no colonies, nor any apparent desire to acquire them, nor will this desire probably arise until the population of this country has overflowed its vast limits, or its great resources become strained to maintain it.

At present our foreign commerce is carried in foreign vessels, and our manufacturers compete with those of other nations in but few markets, when we consider the manufacturing resources of this country.

All these reasons combine to make the United States self-contained to a greater degree than any other important nation, and, as a consequence, we are brought into conflict with the interests of other nations to the least possible extent. For this reason, the chances of war would seem to be at a minimum. But there are not wanting indications that this comparative isolation will soon cease to exist, and that it will gradually be replaced by a condition of affairs which will bring this nation into sharp commercial competition with others in every

part of the world. Even now our commercial relations with our nearest neighbors are clamoring for modification both by sea and land, and in the adjustment of our trade with a neighbor we are certain to reach out and obstruct the interests of foreign nations.

The time cannot be distant when we shall compete in earnest with others for the vast and increasing ocean-carrying trade; the time is near at hand when our own people will find it profitable to carry at least their own goods to foreign markets.

The construction of a canal to form an ocean route between the Atlantic and Pacific will place this nation under great responsibility which may be a fruitful source of danger.

While these changes in our national affairs and relations which loom up in the near future all tend to contribute to the wealth and greatness of the nation, they will also bring with them responsibilities and chances of war which we should prepare to meet. When we consider for a moment the naval force which might be brought against us, in case of war, even by a second-rate power, we are astonished at our own weakness and total lack of preparation. Never in the history of the country have we been so unprepared as now to maintain our rights upon the seas, or to defend our own shores. In years gone by, our ships were as good as any in the world, but while for a quarter of a century we have disregarded all advances in naval warfare, others have steadily pursued a policy of building ships embodying the improvements which have grown in such numbers and character that the modern man-of-war in no way resembles the fighting ships of fifty years ago. Not only, then, have we a navy which is insignificant in numbers, in comparison with those of other nations, but even those vessels which we possess are not capable of meeting their great armored ships. Fifty years ago a ship and her armament could be constructed in a few months,—even in our late war it was possible to improvise a fleet of considerable power from our merchant shipping,—but the fighting ships of to-day require years to construct, and demand for the work such great mechanical appliances that a nation without such ships ready built, in time of war, is certain to suffer defeat. This is, unquestionably, the condition of the United States at this moment.

When we consider the wealth of our country, or our ability to maintain a navy, and the interests at stake in case of war, we are again forced to admit that our navy is insignificant and totally disproportionate to the greatness of the country and to the task which would certainly fall to it in case of war.

If we omit entirely from consideration the property along our coast which is now exposed to destruction, and consider only the exports and imports which are exposed upon the high seas, we find that the value of such property is annually $1,500,000,000. This does not include our coastwise trade, which would double these figures; and this trade would also be exposed to destruction in case of a naval war. While more than 75 per cent of this vast foreign traffic is carried in foreign ships, the exports represent a part of the nation's wealth and would be subject to capture. Nor does the loss of this property adequately represent the loss to the country which would result from its capture in whatever ships it might be carried. The enormous home industries and inland transportation directly dependent upon the continuance of these exports would be paralyzed.

It matters not whether this commerce is carried in foreign ships; if it were to cease, it would produce wide-spread misery. It is not, then, alone sufficient that our sea-ports should be protected against bombardment—they must not be blockaded—our commerce must be free to enter and leave at its accustomed ports. The Board feels that it cannot emphasize this too strongly. If the port of New York alone were blockaded for even three months, it would produce greater confusion and loss than would be directly inflicted by a bombardment of the city, even in its present unprotected condition.

When compared with the foreign exports and imports of other nations, we find those of the United States nearly equal to one-half of those of Great Britain, three-fourths of those of France, five times those of Spain, more than three times those of Italy, and more than three times those of Russia.

The total exports and imports of Great Britain and of the United States have steadily increased during the past ten years, while those of other nations have decreased. It may, then, be accepted as a reasonable belief that the commerce of this country must continue to increase, and that the time is not far distant when it will surpass those of the only two nations which now exceed it. If, then, it be deemed prudent to maintain a naval force capable of protecting this vast and increasing traffic, the United States should possess no insignificant navy.

While the Atlantic and Pacific furnish a practically insurmountable barrier to an invading army, our extended coast-line is a constant temptation to an enemy to assail us from the sea. When we consider the simplicity of the means required to resist an invasion, and

remember the greatness of our population from which armies are to be recruited, and the railway and other facilities for concentrating them upon any threatened points of our coast, we must be convinced that only a powerful army would venture to invade our territory. The vast means of ocean transportation demanded for any considerable army, and the difficulties to be overcome in keeping up its supplies, would, manifestly, render it impossible to invade our country. We have, then, only to fear a naval attack, which may vary from the marauding attack of a few cruisers upon our shores or commerce, up to the organized and destructive attack of a well-appointed fleet of armor-clads. How shall we best protect ourselves against these? Shall we place our main dependence upon fortifications for our principal ports and permit ourselves to be shut up within them, and suffer our vast commerce to be driven from the seas? or shall we be prepared to maintain our rights at sea, to keep our ports open to our trade, and, incidentally, protect the ports?

While feeling reasonably secure against any invasion of our territory by an enemy, we should redouble our efforts to protect ourselves against the one certain form of attack in case of war, and the only complete protection is to be found in an efficient and sufficient navy.

Considering, then—

(1) That we are a nation possessed of great and increasing wealth;

(2) That much of this wealth must pass to and fro across the ocean or along our coast, where it is exposed to capture or destruction in case of war;

(3) That we are now totally unprepared—even against second-rate powers—to protect our commerce, to prevent the blockade of our ports, or to maintain our rights and honor away from home;

(4) That these objects can only be secured by a navy;

(5) That while we are now at peace with all nations, this fortunate condition of affairs may not always continue:—it is evident that we should proceed with all possible dispatch to provide a navy of such a character and magnitude as will efficiently serve these purposes.

To do this is a naval problem which depends for its complete solution upon several conditions, which, in turn, are fixed or known with a moderate degree of exactness.

The Board considers these conditions under three heads:

The *first* may be stated as the naval strength of our possible enemies, which is, in all cases, so far as concerns the naval strength

of individual nations, known with precision; but the possibility of combinations, either for or against us, introduces an element of uncertainty which, under given circumstances, may be estimated but cannot be anticipated.

The *second* condition is the proximity of the respective bases of coal and ammunition supplies to the area which we might be called upon to attack or defend. The imperative necessity of an ample supply of coal and ammunition to insure the maximum efficiency of a modern fighting ship renders it certain that the nation which is best supplied in these respects will have an enormous advantage.

Third, the extent of the area to be attacked or defended. The greater the area or coast-line to be defended against a given force, the greater will be the force required; whereas, in many cases the force required to attack may be much smaller than the defending force. A few cruisers may attack and greatly injure the commerce of a nation having many cruisers in search of the marauders. A few armor-clads may attack and destroy public stores or dock-yards, notwithstanding a much greater defending force. Consequently, if we know the naval strength of our possible enemy, his facilities for replenishing his supply of coal and ammunition as compared with our own facilities, both acting in any given part of the world, and give due weight to our respective positions in regard to the areas to be attacked or defended—that is, whether we are defenders with a convenient base, or the reverse—we shall have a reliable basis upon which to estimate the naval force which should be maintained by the United States.

First, then, if other conditions were equal, we should maintain a navy at least equal in strength to the most powerful navy in the world, on the theory that we might have to fight such a nation. But the second condition, viz., proximity of bases of supply, greatly modifies this estimate as far as the magnitude of the navy required for the protection of our interests in the western hemisphere is concerned, and these are our greatest interests; for in this part of the world we should be acting near our own base, while most European nations would be separated several thousands of miles from any base of supply—a fact which would serve to exclude some of the most powerful ships in the world from acting against us, provided our naval strength was sufficient to prevent our enemy from seizing some of the islands along our coast and establishing the necessary bases, or taking possession of Long Island Sound, Chesapeake Bay, or other suitable body of water where colliers could anchor in security.

In those cases where nations have bases of supply in proximity to our coasts, vessels of very moderate coal endurance could act against us; they would, however, be forced to defend their bases and protect all supplies sent to them. The proximity to our shores of naval bases of supply, or their existence even at more distant points which would in any degree assist an enemy, is a consideration of the gravest import to us, both as regards our national safety and in deciding the naval force we should maintain. It would, therefore, in case of war, lead to an immediate struggle between the possessors of such naval bases near our coast for their protection, and ourselves for their destruction. We should be prepared with a naval force adequate to such work, and only the most powerful armor-clads would suffice. Whatever force our enemy could fairly be expected to assign to such duty, we should be able to destroy, beyond a doubt. To fail in this would multiply the destructive force of our enemy, and leave us helpless to resist direct attacks upon our own seaboard.

We find, then, in this consideration, a limit fixed for our naval strength, which, it is probable, we need not exceed, and with less than which we cannot rest secure.

To be able in case of war to destroy completely, at its outbreak, every base of supplies belonging to our enemy which should be in proximity to our country, and at the same time to protect the converging highways of our commerce, both foreign and coastwise, would represent the principal demand to be made upon our navy for purposes of defense, and, hence, for any purpose.

By destroying all proximate bases of supply we force the enemy back, and exclude from the contest all vessels of limited endurance. The following table exhibits the endurance of the principal armor-clads and cruisers of Europe, now built or building, classified according to endurance. The table includes only such vessels as could act against us were we provided with the naval force above referred to. With our present naval strength, every vessel of an enemy, without respect to endurance, armor, or armament, would be effective against us; for where such enemy does not already possess near bases of supply, they could easily be established along our coasts at points inaccessible to a land force, and our whole coast completely invested.

[Numbers of table give the *total* number of ships having at least the endurance given at head of column.]

ARMORED SHIPS.

Nation.	Effective battle-ships.							
	Endurance at 10 knots exceeding—				Maximum endurance exceeding—			
	7,000	6,000	5,000	4,000	12,000	10,000	8,000	6,000
Great Britain :								
Complete	8	12	15	20	6	7	15	20
Building.....	10	10	10	10	..	10	10	10
France :								
Complete	..	..	4	19	..	..	..	19
Building.....	..	..	2	4	..	..	..	4
Spain :								
Complete	..	..	..	1	..	..	..	1
Building.....	..	..	..	..	..	..	..	..
Italy :								
Complete	2	2	2	4	2	2	2	4
Building.....	3	3	3	6	3	3	3	6
Germany :								
Complete	..	..	..	4	..	..	..	4
Building*.....	..	..	..	..	..	..	..	..
Russia :								
Complete	..	..	3	3	..	..	3	3
Building.....	..	..	7	7	..	..	7	7

Nation.	Effective armored cruisers.							
	10 knots endurance exceeding—				Maximum endurance exceeding—			
	12,000	10,000	8,000	6,000	15,000	12,000	9,000	6,000
Great Britain :								
Complete	..	..	7	9	..	9	9	12
Building.....	..	..	..	..	..	..	..	..
France :								
Complete	..	..	..	..	..	..	..	..
Building.....	..	..	..	5	..	..	5	5
Spain :								
Complete	..	..	..	..	..	..	..	..
Building.....	6	6	6	6	6	6	6	6
Italy :								
Complete	..	..	..	..	..	..	..	..
Building.....	..	..	..	..	..	..	..	..
Germany :								
Complete	..	..	..	..	..	..	..	..
Building*.....	..	..	..	..	..	..	..	..
Russia :								
Complete	..	..	..	..	..	.	3	3
Building.....	..	..	2	2	2	2	2	2

* Four first-class armor-clads are being laid down, of 9000-10,000 tons; no information as to endurance.

[Numbers of table give the *total* number of ships having at least the endurance given at head of column.]

EFFECTIVE PROTECTED CRUISERS.

Nation.	10 knots endurance exceeding—				Maximum endurance exceeding—			
	12,000	10,000	8,000	6,000	15,000	12,000	9,000	6,000
Great Britain:								
Complete	..	..	9	23	4	9	23	47
Building	2	11	40	40	11	40	40	40
France:								
Complete	..	..	..	4	..	..	4	4
Building	..	..	..	5	..	..	5	9
Spain:								
Complete	1	1	1	1	1	1	1	1
Building	..	3	3	3	..	3	3	3
Italy:								
Complete	1	1	1	9	1	1	9	9
Building	..	..	..	6	..	..	6	6
Germany:								
Complete	..	..	..	..	..	..	..	..
Building*	..	..	10	10	..	10	10	10
Russia:								
Complete	..	..	..	3	..	..	3	3
Building	..	..	..	..	..	..	..	..

The above table does not take account of coast-defense vessels nor of armored ships constructed prior to 1870. Some of their older armored ships are having new engines put in by the *English*, and thus becoming armored cruisers. *No data on this.*

No vessels of less than 1000 tons have been considered with protected cruisers.

Armored ships constructed between 1868 and 1875 having less than 5000 miles total endurance have been considered coast-defense vessels. Half a dozen English ships under this head might still be considered effective battle-ships.

Similar ships of other navies (not considered above) are practically obsolete.

Assuming that a vessel, or a small number of vessels, cannot operate at a greater distance from a base than one-third of her endurance,—and even at this distance some dependence would have to be placed upon coaling at sea from captured vessels or from colliers,—it may be seen that a large proportion of these ships cannot attack us with a base of supply so distant as Europe. Probably a fleet of overwhelming strength could bring colliers with it, and detach a sufficient force to protect them in some sheltered place on the coast where coal could be taken on board, and thus to a limited extent make up

for the lack of a protected base of supplies. This contingency has been considered by the Board.

Great Britain will soon possess seventeen battle-ships having the necessary endurance to act from a home base, nine armored cruisers, and sixty-three protected cruisers.

Of similar vessels, France will soon possess five armored cruisers and nine protected cruisers.

Spain will soon have six armored cruisers and four protected cruisers.

Italy will have five battle-ships and six protected cruisers.

Germany will have ten protected cruisers.

Russia will have five armored cruisers and three protected cruisers.

With coaling stations near our coasts, the conditions would be entirely changed, and Great Britain under these new conditions will soon be in possession of the following vessels which could operate against the United States: thirty battle-ships, twelve armored cruisers, and eighty-seven protected cruisers.

France, in like manner, will soon be in possession of the following vessels which could operate against the United States: twenty-three battle-ships, five armored cruisers, and thirteen protected cruisers.

Spain will have six armored cruisers and four protected cruisers.

Without bases of supply on this side of the Atlantic, the three first-named nations combined would have one hundred and thirteen modern ships of all classes which could operate against the United States. Of this number, but seventeen are battle-ships.

With their present bases of supply intact, these same three nations possess one hundred and eighty modern ships, of which fifty-three are battle-ships which could operate against this country.

As above stated, the ships here enumerated as effective ships comprehend only ships of recent construction and great power. If all England's battle-ships were included, the number given for that nation would have to be placed nearer fifty than thirty; hence the manifest need of destroying such bases at the outset. So great would be the advantage of an enemy in protecting such stations, and so much also would it diminish his power if they were destroyed, that we might be assured of a desperate struggle over their possession.

No more forcible illustration can be found of the importance of these bases of coal and ammunition supply, not to mention the facilities which they also furnish for repairing vessels, than in the fact that without them, were we possessed of an adequate force, no nation

could send an ironclad against us, except England and Italy. This statement is subject to modification in case of an alliance which might render available bases of supply to a nation otherwise without them.

To protect our ocean highways of commerce involves the protection of the approaches to all our commercial ports, and consequently their protection against blockades or bombardment. Less than this we should not be satisfied with, and to accomplish these objects fixes the limits of the naval strength required by this country. In basing the necessary strength of our navy upon these requirements, the Board has not lost sight of the possible alliances which might be formed by either side, and, considering the political relations existing between European nations, it may fairly be assumed that the alliances we would be able to form would more than counterbalance those formed against us.

In this assumption there is, however, an element of uncertainty which prudence would suggest should discount any such assumed advantages. The most powerful navy of these three nations is that of Great Britain, and her effective force is now thirty battle-ships and one hundred cruisers; but the conditions will not arise when that or any other nation possessing an important commerce can detach all her effective navy from her own coast for distant operations.

On the other hand, a considerable preponderance of defensive force must exist to accomplish the purposes above set forth, and especially in heavy ships suitable to the attack of fortified places within a thousand miles of our nearest naval depot.

The Board is therefore of the opinion that the following vessels, to be hereafter described, should be added to the navy of the United States:

Battle-ships of great coal endurance	10
Battle-ships of limited coal endurance	25
Cruisers of 4000 tons and over	24
Torpedo cruisers of about 900 tons	15
Special cruisers for China service of about 1200 tons	5
Rams	10
Torpedo-depot and artificer's ships	3
Ships of all classes	92

Besides one hundred first-class torpedo-boats and numerous second-class torpedo-boats carried by battle-ships of great endurance and the larger cruisers and torpedo-depot ships.

In general terms, the battle-ships of great coal endurance would constitute the basis of a fleet which might be detached, in whole or in part, for distant service and for the purpose of cruising against the enemy; having the power to remain at sea during a long period, and to attack points on the other side of the Atlantic.

The Board deems it absolutely essential that we should possess this number of battle-ships of such endurance, for it is evident that a policy of protection without the power to act offensively, even to carrying war to the very doors of an enemy, would, at the present time, double the force with which we would have to contend. For, an enemy, knowing it was possible for such a fleet to appear upon its own coast, would be obliged to assign a superior force for its protection, thus greatly diminishing that to be sent against us.

The battle-ships of limited endurance would constitute a fleet of heavily armed and armored ships, having the necessary endurance to act at any point along the Atlantic or Pacific coasts or in the Gulf of Mexico, and within a thousand miles from a depot of supplies. They would serve the purpose of keeping our ports open and destroying an enemy's bases of supplies within a thousand miles of our coast.

While the great coal and ammunition endurance required in the first-class battle-ships necessitates a vessel of 10,000 tons displacement, with a draught of 25½ feet of water, battle-ships of endurance limited as above defined, carrying even a more powerful main battery, can be constructed upon a displacement of 8000 tons, and a draught of 23½ feet.

The limited depth of water to be found at the entrance to the harbors of the Atlantic and Gulf ports makes it necessary that even our first-class battle-ships should be constructed on the least possible draught.

Three classes of these battle-ships of limited endurance are recommended, all having the same general characteristics of speed and manœuvring power, in order that they might act together as a unit or in squadrons to the greatest possible advantage. This is a consideration which the Board deems of the utmost importance, as it would give such a fleet an advantage over any fleet now in existence. At the same time the diminished draught of water of the smaller vessels permits them to enter ports along our Southern coast, which the larger vessels could not enter. The main object of all these battle-ships is the protection of our own coast.

The Board deems it unnecessary to indicate further in this report the disposition to be made of these vessels to accomplish this object.

In considering the general type of these vessels, the Board has naturally investigated carefully the merits and demerits of the essentially American monitor type. As a result it finds that this type of vessel is adapted only to smooth-water service, and that the conditions of its efficient working are therefore at variance with a large part of the duty demanded. As it is believed that a very wide misconception exists on this subject both within and without the navy, the leading features of the investigation are given in the Appendix B.

The 22-knot protected cruisers possess the greatest endurance, and are intended to capture or destroy the fastest merchant vessels in the world, while they will also be capable of fighting vessels of their own class.

The cruisers of 20 knots speed are to serve the same general purpose, being, however, better capable of fighting, having the same battery, and great, though less, endurance, with greater protections, on a less displacement.

The armored cruisers have the fighting power and protection still further developed, and they would probably overpower any vessel of the cruiser type now built or projected.

The Board has carefully considered the question of protection for the guns and crews in all these cruisers. The development of rapid-fire guns, especially of moderate caliber, and the large number now carried, renders it absolutely necessary that the gun's crews should be protected, or they could not remain at their guns. It is believed that within certain limits the weight assigned to such protection is far more useful than the same weight in additional guns.

It is, perhaps, unnecessary to state that a certain proportion of these cruisers of all types would find their proper field of usefulness in destroying the commerce of our enemy, while the remainder would form necessary constituents of the squadrons, especially in offensive operations. Commerce upon the high seas is the most sensitive of all interests in time of naval war. It is difficult to protect and easy to destroy.

The Board does not consider it well to include any vessels of the Vesuvius type in the programme, as being of uncertain value in naval warfare. At the same time it has no wish to discountenance experiment in naval weapons such as the dynamite guns or the submarine torpedo-boat. On the contrary, it would appear wise for a nation of

such undoubted inventive ability, possessing no large naval establishment to be depreciated by the successful development of such weapons, to devote a certain amount of attention to them. Their consideration, however, is rather beyond the province of the Board.

The tonnage, cost, and proportion of ships of different types in the proposed programme are as in the following table:

Naval Programme.

No.	Type.	Displacement of each.	Aggregate displacement of type.	Approximate total cost.
		Tons.	Tons.	
10	First-class battle-ships of great endurance	10,000	100,000	$56,400,000
8	First-class battle-ships of limited endurance	8,000	64,000	39,890,000
12	Second-class battle-ships of limited endurance	7,100	85,200	52,200,000
5	Third-class battle-ships of limited endurance	6,000	30,000	18,000,000
10	Rams	3,500	35,000	18,700,000
9	Thin-armored cruisers	6,250	56,250	28,800,000
4	Protected cruisers	7,500	30,000	15,760,000
9	do.	5,400	48,600	25,200,000
2	do.	4,000	8,000	4,200,000
5	Special cruisers, about	1,200	6,000	2,400,000
15	Torpedo cruisers, about	900	13,500	7,000,000
3	Torpedo-depot and artificer ships.	5,000	15,000	6,500,000
92	Ships of all classes	..	491,550	$275,050,000
100	120-foot torpedo-boats	65	6,500	6,500,000
				$281,550,000

Including new vessels completed, building, or already authorized—chiefly in the cruiser classes—the proposed naval establishment of the United States would consist of the following number of vessels of each class, with approximate tonnage and cost.

The Maine and 7500-ton "armored cruiser" authorized are classed with the Texas, as third-class battle-ships, as being sufficiently exact for our present purposes. The coal endurance of the Maine, indeed, is less than that of many recent battle-ships, and her sail power is a supplement of doubtful value.

Proposed naval establishment of the United States, including vessels already built or appropriated for.

No.	Type.	Displacement of each.	Aggregate displacement of type.	Approximate total cost.
		Tons.	Tons.	
10	First-class battle-ships of great endurance	10,000	100,000	$56,400,000
3	Third-class battle-ships of great endurance	6,300 6,650 7,500	20,450	11,000,000
8	First-class battle-ships of limited endurance	8,000	64,000	39,890,000
12	Second-class battle-ships of limited endurance	7,100	85,200	52,200,000
5	Third-class battle-ships of limited endurance	6,000	30,000	18,000,000
6	Harbor-defense monitors	(4) 3,815 (1) 4,000 (1) 6,060	25,320	25,000,000
1	Cruising monitor	3,800	3,800	1,900,000
11	Rams	(10) 3,500 (1) 2,000	37,000	19,500,000
9	Thin-armored cruisers	6,250	56,250	28,800,000
4	First-class protected cruisers	7,500	30,000	15,760,000
10	" " "	5,400	54,000	28,000,000
12	Second-class protected cruisers	3,000 to 4,500	45,600	22,500,000
6	Third-class protected cruisers	1,700 to 3,190	11,100	5,500,000
10	Gun-vessels and dispatch-boats	850 to 1,500	11,450	4,500,000
16	Torpedo cruisers (including Vesuvius)	About 900	14,500	7,500,000
3	Torpedo-depot and artificer ships	5,000	15,000	6,500,000
126	Ships of all classes	.....	603,470	$342,950,000
101	120-foot torpedo-boats	65	6,565	6,565,000
				$349,515,000

It will be observed, comparing the above tables, that the grand total of cost includes the sum of $67,965,000 already expended or appropriated for vessels, chiefly of the cruiser class, now completed or in course of construction.

The following summary gives the distribution of the elements of the fleet, including all vessels built, building, appropriated for, and recommended by the Board.

Battle-ships of great endurance.—Thirteen vessels of an aggregate tonnage of 120,450 and total cost of $67,400,000.

Battle-ships of limited endurance.—Twenty-five vessels of an aggregate tonnage of 179,200 and total cost $110,090,000.

Harbor defense and rams.—Seventeen vessels of an aggregate tonnage of 62,320 and total cost $44,500,000.

Cruisers of all classes, including gun-vessels and dispatch-boats, sixty-eight vessels, of an aggregate tonnage of 225,500 and total cost $114,460,000.

Torpedo-depot and artificer ships.—Three vessels of an aggregate tonnage of 15,000 and cost $6,500,000.

Sea-going torpedo-boats.—One hundred and one of an aggregate tonnage of 6565 and cost $6,565,000.

Reliance is placed on the development of an auxiliary navy of fast, well-built merchant steamers to supplement the rather small proportion of cruisers contemplated in the programme.

In attempting to outline any scheme for the execution of the proposed naval programme, we are met at the start by very unsatisfactory conditions as to armor supply; and the most pressing need of the navy is armored ships. At present there exists in the United States but one establishment which will, in a short time, be able to furnish armor of the character needed.

On the 1st of June, 1887, a contract was signed with the Bethlehem Iron Company, of Bethlehem, Pa., for gun steel and armor, including about 5400 tons of vertical armor and bolts. The necessary plant was to be ready within two and a half years of the date of contract, and all the armor to be delivered within two years thereafter, or early in 1892. All this armor is needed for ships under construction, and meanwhile there is required about 3000 tons, not yet contracted for, for ships building or authorized. The Board is of opinion that if this plant continues to be the only source of supply, no large quantity of armor for new vessels can be delivered before 1895. The existing lack of ability to furnish armor in large quantities is entirely due to the absence hitherto of a sufficient demand for it. Were our steel-makers assured sufficient orders, the plants necessary for the manufacture of heavy armor would certainly be created.

Upon this ground, therefore, the Board believes that it would be wise for appropriations to be made at once for a considerable number of heavily armored ships, which should, however, be laid down only as fast as the Department is assured that the developing resources of the country will admit of their rapid completion. On the other hand, should a policy be adopted of appropriating only small sums for armor and armament, it is feared that the necessary

stimulus to enlarging present and creating new plants will not be given, and in such case, since the armor of internal bulkheads and redoubts of armored ships built with fair dispatch will be wanted certainly within two years of the laying of their keels, the Board is of the opinion that the requisite armor will not be furnished in time for ships whose construction is begun in 1890.

In the type of battle-ships of great endurance and of thin-armored cruisers submitted, a large proportion of the armor protection is afforded by plates of five inches or less in thickness, but this, it is believed, could be readily manufactured in this country within the necessary time.

Besides the condition of armor supply, a certain restriction is imposed by the working facilities of the country for ship and engine building of the kind required. The slow progress which has been made since the first vessels of the new navy were appropriated for is a warning that expectations should be moderate for some years to come. The average annual output for the navy for the last six years is only 4000 tons, and the present rate may be placed as not more than 7500 tons. Any adequate progress will therefore be accompanied by great expansion of the ship-building industries of the country.

The Board has carefully considered the facilities possessed by the ship-building establishments, including navy-yards now in existence or soon to commence work, together with the supply of skilled labor available. The practical limitation is found in the latter element. Were the urgency declared and very high prices offered for ship-building labor, the demand could probably be rapidly filled by drawing extensively on labor employed in other occupations. Time is necessary for even the stimulated development of the industry in any healthy manner.

Again, it is now very generally recognized that the best naval ship-building policy lies in concentrating all available energy upon such a number of ships as can be completed in a reasonable time, and the efficiency of their type made available as soon as possible, rather than in laying down at one time a greater number of vessels requiring a much longer time to complete, during which none are available, and the efficiency of the type is depreciating.

From all these considerations the Board is of opinion that about 70,000 tons may profitably be laid down in the next two years, the distribution among the different types depending upon the capacity

of the various ship-building establishments of the country, some of which are adapted only to the building of unarmored ships. As much as possible of this aggregate tonnage, however, should be in battle-ships.

The Board respectfully recommends that designs be prepared in anticipation of appropriations, as much time has been lost heretofore from this cause, and it has frequently been necessary to adapt the designs to the appropriations, which is manifestly wrong. Should such a policy be followed in the design of the battle-ship recommended, it would be certain to result unsatisfactorily.

Commencing with 14 per cent of the programme to be laid down during the next two years, under the conditions stated, it is believed that the whole work may be carried on at the following rate:

Fourteen per cent to be laid down the first and second years; 10 per cent to be laid down the third and fourth years, and 12 per cent to be laid down each succeeding year, and the programme can be completed in fourteen years.

It is evident that at the end of the third year 24 per cent of the total would be under construction or completing.

It is herein contemplated and urged that the four principal navy-yards, viz., New York, Boston, Norfolk, and Mare Island, will be in the least practicable time completely equipped for constructing the hulls and machinery of all the classes of vessels and their equipment, and with largely increased facilities for docking.

The Board also recommends that the League Island navy-yard be equipped as soon as possible for the construction of the hulls of vessels, believing that such work may be advantageously done there without the expense and delay consequent on equipping this yard for all classes of work. This may be the better done, as it is believed that the Department will find it advantageous to place contracts for much machinery separately from the hulls, as is very generally done in foreign countries.

In consideration of the undetermined value of many accepted and other proposed means of naval attack and defense, as included in the types of ships in use and proposed, and of the very large expenditure proposed for the building of the fleet on this basis, the Board has to recommend that a wide series of artillery and torpedo experiments be made: to include the effect of common and high-explosive shells on coal, woodite, cellulose, and other water-excluding materials and devices contained in compartments; the attack of inclined armor

and decks; the attack of thin-armored sides, and the best form and material of shells to carry various explosives through them; the composition of such explosives; the efficiency of compressed paper as backing for thick and thin armor and for deck armor; torpedo nets and other forms of torpedo defense. To begin these experiments, $100,000 should be appropriated for immediate use.

The Board has also to call attention to the necessity of increased coaling facilities both at our navy-yards and coaling stations, and for coaling ships at sea. For this latter purpose it is not considered necessary to build special colliers, provided suitable appliances can be determined upon and readily applied to ordinary colliers, as is believed may be done.

GENERAL CONSIDERATIONS RELATING TO THE DESIGNS.

What follows is intended to present the general features of the principal types of the vessels recommended in accordance with the present state of war-ships designed in the light of recent developments in the elements of naval attack and defense, and especially of the steel armor-piercing shell and of shells charged with high explosives.

As these latter elements have controlled certain of the prominent features of many of these and of other recent designs, while experience with them is almost entirely foreign to our navy, it is well to reiterate here the necessity of early and extensive experiment, both as to the nature of such attacks and the efficiency of the means taken to receive them.

Meanwhile, as the results of such experiments cannot be expected to condemn positively existing means of defense on the one hand, or on the other to develop a perfectly satisfactory defense on the same weight, but only to evaluate more closely the present methods or produce others of somewhat greater efficiency, construction may be proceeded with in the confidence of possessing such features at least as efficiently as in the most recent constructions of other nations.

As a general naval progress develops improvements in the means of warfare, they should be embodied in these vessels as they are successively laid down, to the end that each ship shall represent the most approved ideas in construction at the time she is completed. Yet a fairly complete scheme on paper, for a fleet of present construction, adapted to the conditions before laid down, cannot fail to furnish a most useful basis for some years, besides affording the means of determining the approximate aggregate cost and applying directly to such vessels as are to be immediately commenced.

In order that the scheme as prepared may be so used with confidence, it is considered well to lay down briefly the general basis adopted in the designs for each of the main elements, such as hull, armor, guns, machinery, etc.

Hulls.—The best construction of mild steel as at present used is contemplated with the following general differences. Machine riveting should be used in all framing and elsewhere, whenever possible, and the rivet material* should throughout be stronger than now used in the navy. Also, most of the material within the shell of the ship, such as frames, bulkheads, plating—other than stringers—of decks, all supports to redoubts and guns, and such parts normally in compression, should be of material of from 10 to 20 per cent greater tensile strength and elastic limit than now used.

As little wood-work should be used as may be necessary for the comfort of the people and the dry stowage of supplies. Cementing is, generally, by admiralty composition. The weights assigned to hull and fittings admit of scantlings equal to or exceeding those of recent analogous European constructions, and are, throughout, ample with careful distribution of material and fastenings and close attention to wood-work and fittings.

In all cases there are excluded from these weights all material specially relating to the protection of the hull and gun positions by heavy armor, such as plating, framing, etc., behind armor, very commonly included in the weight of hull, but here considered as rather belonging to the protection. An exception is made of the framing to thin armor of casemates or belts. All heavy plating for gun protection is likewise excluded.

Armor and protective material.—All steel armor has been contemplated. The construction of the heavy belts and bulkheads is with the armor on thin backing against heavy plating in two thicknesses, supported by a close cellular structure and inner mantlet, the numerous bolts to stand on sleeves within the cellular structure.

The material of the backing is teak, subject to experiment as to the advantages of compressed paper in large plates of the required thickness, which may be less than that of the teak as designed. The thin armor of 4 to 5 inches is to be worked without backing on heavy transverse frames, doubled at the butts, with a deep longitudinal along the middle of the plates.

* The advantage of chrome and nickel steels for this purpose, as possessing greater toughness for the same strength than carbon steel, should be investigated, though the changes contemplated here relate to the ordinary material.

All armor and protective decks are to be worked in single thickness on deep beams of channel or Z section, with a water-tight jacket of 10-pound plating on the lower flanges of the beams between the wing bulkheads. Where sufficient longitudinal support is not afforded by bulkheads, it is to be given by carlings in short lengths between the beams.

A prominent feature in most of the designs is the use of special water-excluding material in the wings. The material known as *woodite* has been adopted for this purpose, subject to the experimental determination of a more suitable substance. Woodite is a light material, composed essentially of cork and rubber. As now made, it lacks elasticity, and has no leak-stopping quality, but fills about 95 per cent of the volume containing it, leaving practically no room for entering water except where the projectile has passed. It may be mined away by shell exploding within it, but, having consistency, will not run out of a shot-hole like cellulose. It is largely relied upon in these designs in connection with ordinary coal and patent fuel over heavy decks for the maintenance of ample stiffness in vessels not heavily armored, and along the unarmored water-line of belted ships, against all forms of gun-attack. Its weight has been figured at 12 pounds to the cubic foot of gross volume of compartments as filled. If packed in tin boxes, as may be found desirable, a somewhat greater weight will be required.

In the battle-ship and protected cruisers the longitudinal bulkhead of the woodite belt is water-tight all fore and aft, and subdivision within is by transverse bulkheads alone throughout the coal bunkers, so as to avoid the serious list consequent on longitudinal subdivision in these parts of ordinary protected ships under conditions of water-line damage when deeply laden. *Cellulose* is to be used in the coffer-dams to hatches in heavy decks.

Protection is afforded the 12- and 13-inch guns by turrets differing somewhat from the common form in being lower in front than elsewhere, the port openings extending into the turret crowns and being covered by 3-inch aprons carried on the guns. Barbettes are used only with the 10-inch guns on the smaller battle-ship of limited endurance, in order to keep the size of the ship within certain limits.

In the vessels designed to take any large amount of gun punishment, the guns of 5-inch and over, not protected by heavy armor, are given completely localized protection, being mounted in low barbettes of $2\frac{1}{2}$ to $3\frac{1}{2}$ inches thickness, with equivalent complete

shields, entered by door in rear, carried over them, turning with the piece. The connection of movable shield to fixed barbette is to be such as to avoid jamming on moderate injury near the joint, while being tight enough to prevent neighboring explosions of heavy shell —including those containing moderate amounts of high explosive— and the blast of adjacent guns, from being felt within.

In such vessels without a casemate, the barbettes are continued to the armor deck by thick cone and tube bases, with external radial frames, and lightly connected by plate rings and brackets at the junctions with other decks. The tubes open into passages below the armor deck, and the ammunition is to be passed up through the tubes and cones, the guides, etc., being supported as far as possible without connection to them.

In the ordinary protected cruisers, complete shields are fitted to the 8-inch guns above the deck, turning with them. Allowance is made for power—preferably electric—for turning the 8-inch guns and shields. The 5-inch guns are protected by thick plating over the sponsons, extending for a short distance on the side, with open ports covered by inner wing-shields on the gun.

Guns.—After long discussion it was determined that the largest guns to be carried should be of 13-inch caliber, 35 calibers long, and weighing about 60 tons, to be mounted on the largest ships of limited endurance. The greater number of the heavy guns, including those for the battle-ship of great endurance, to be 12-inch, 35 calibers, weighing about 50 tons.

These guns are all mounted in the middle line in turrets above redoubts with single loading positions fore and aft.

In all the large cruisers a certain amount of heavy shell fire and armor-piercing capacity is afforded by the two 8-inch bow and stern guns, while the greater part of the volume of fire is assigned to the 5-inch guns.

One type of large rapid-fire gun, 5 inches caliber and 3 tons weight, is used throughout, as being considered the largest caliber admitting of reasonably convenient fixed ammunition, and well adapted to the attack of unarmored or lightly protected sides. Two types of smaller rapid-fire guns are used—the 6-pounder and 1-pounder—of which, in all cases, four of the latter are mounted for boat attack on the first deck above water, on screw traversing mounts, to stow entirely within the ship's side without projections.

In all the battery plans, the governing considerations have been to

obtain a large proportion of the total fire on all bearings, and, in general, equally forward and abaft the beam, while retaining the greatest through a considerable angle of the broadside, and that the lightly protected guns should be distributed as widely as possible, and not more than two in the same line to be disabled by a single projectile. It is believed that these objects have been well attained in the plans submitted.

Machinery.—The machinery throughout is designed for three-cylinder, triple-expansion, with a boiler pressure of 160 pounds; the expansion gears to admit of realizing a combined mean effective pressure by card at the highest power of generally 41 pounds per square inch of low-pressure pistons. In all the vessels of great endurance, and in the ram, there are four sets of vertical engines, two driving each screw. Such an arrrangement in these ships admits of much better proportions with vertical engines accompanied by smaller rubbing velocities and better lubrication, greater reliability, less first cost, and above all, greater economy at low cruising speeds with the forward engines detached, the after engines alone driving the screws and using a good head of steam with most economical expansion. While such engines weigh more by 6 to 7 per cent than single engines of equally good proportions, there is not so much excess weight over engines of the proportions generally necessary, and the slightly greater weight is much more than compensated for by the advantages gained.

The boilers are of cylindrical types in general use. Forced draught by closed stoke-holes is contemplated. Except in the vessels of limited endurance, there are about 1.8 square feet of heating surface per indicated horse-power at maximum power. In the vessels of limited endurance, about 1.95 square feet of heating surface is allowed under the same conditions. As in all the turret-ships a liberal allowance of steam is made for turret and other auxiliary machinery, a greater proportion of heating surface exists when such auxiliaries are not in use. With such large boiler powers very good speeds may be continuously and economically maintained at sea under conditions producing no injury to the boilers, as shown by the appended Table A.

A comparative statement will show the greater weight necessary for the comparative comfort and economy effected in the machinery of these designs, as compared with recent foreign designs. The new British battle-ships of about 14,000 tons, 13,000 indicated horse-

power, and 17½ knots speed, are allowed a weight of 1100 tons for propelling and auxiliary machinery. In the proposed design of United States battle-ship of 10,000 tons, 11,000 indicated horse-power, and 17 knots speed, the weight assigned to propelling machinery, including donkey boiler and stores, is 1215 tons, although it should be stated that the performance predicated of the latter design is not so good as that of the former. The Board is better satisfied with the balance of qualities afforded by the basis of working of the machinery as adopted, at least under existing conditions.

Endurance.—The coal endurance at 10 knots is based on a consumption for all purposes at the rate of 1.8 pounds per indicated horse-power in vessels fitted with double engines on each screw, and 1.9 pounds in the others. The steaming distances under different conditions are given in Table A.

The ammunition endurance at the load displacement has been determined in view of the following considerations:

(1) The intended service of the vessel: being greater, other things being equal, the greater the endurance of coal and supplies.

(2) The size and nature of the piece, and the rapidity of its service.

(3) The degree of protection afforded.

(4) The position and train or arc of bearing.

(5) The number of pieces of the same kind in battery.

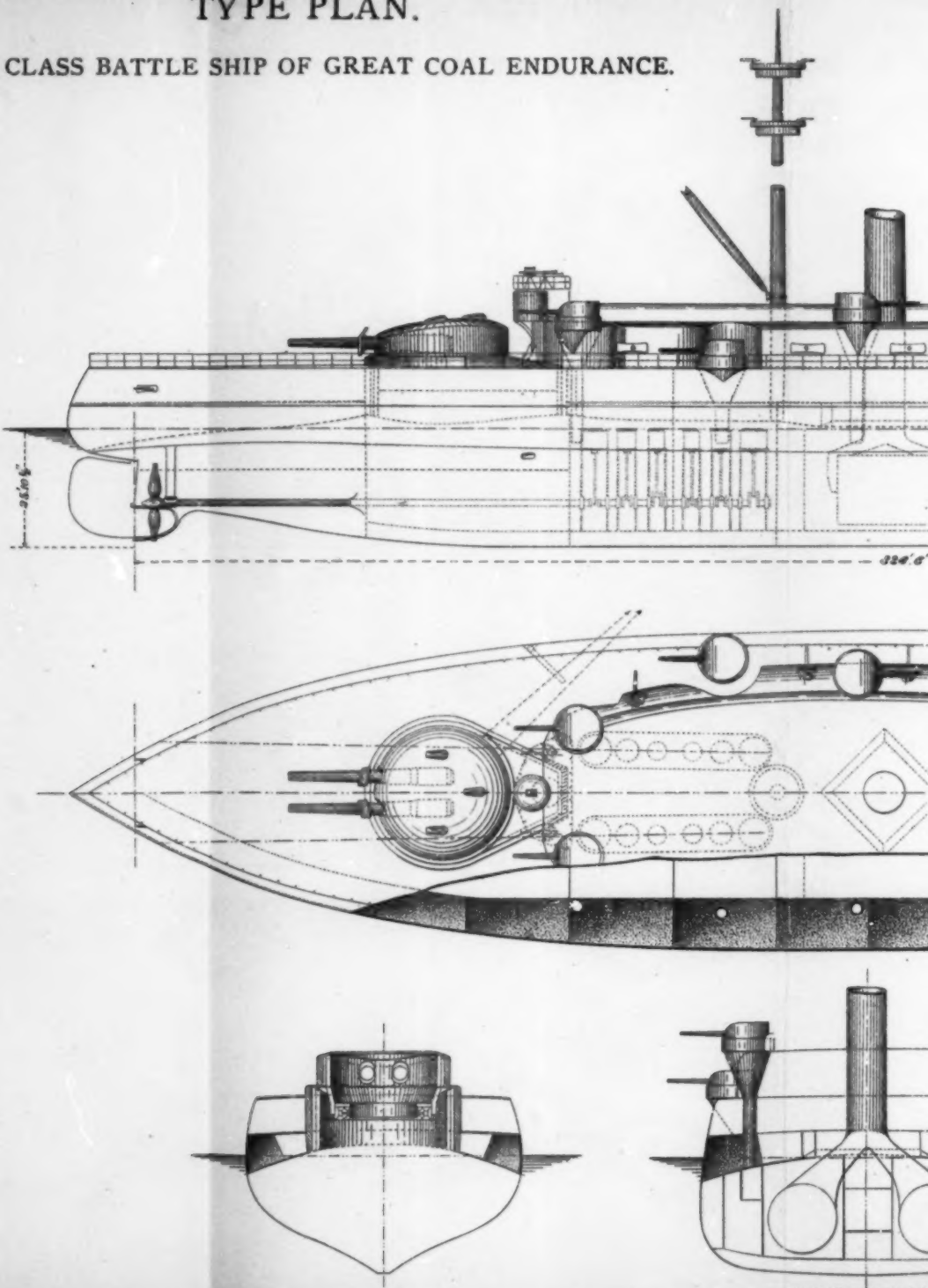
The basis has been an allowance of eighty rounds per gun for the 12-inch guns of the design of battle-ship of great coal endurance. The endurance of provisions and small stores on the load displacement is generally for 50 per cent longer than the total coal endurance at 10 knots, being for the cruisers three months, for the battle-ship two months, and for the ships of limited endurance one month.

The water supply is based upon the considerations of allowing at once for considerable derangement of the distilling apparatus and for the water to become thoroughly potable when used. It is thus practically alike for all the vessels, and the tank capacity is fixed at one gallon per man for 15 days. As the tanks are not, however, kept normally full, the corresponding weight is taken to include water carried for sanitary purposes.

Cost.—The costs given will be distinguished from the ordinary contract price of hull and machinery, being for final costs for the best work of the character contemplated on what is considered to be a fair basis for such constructions in the immediate future. As much of the work is larger than has yet been undertaken, and the circum-

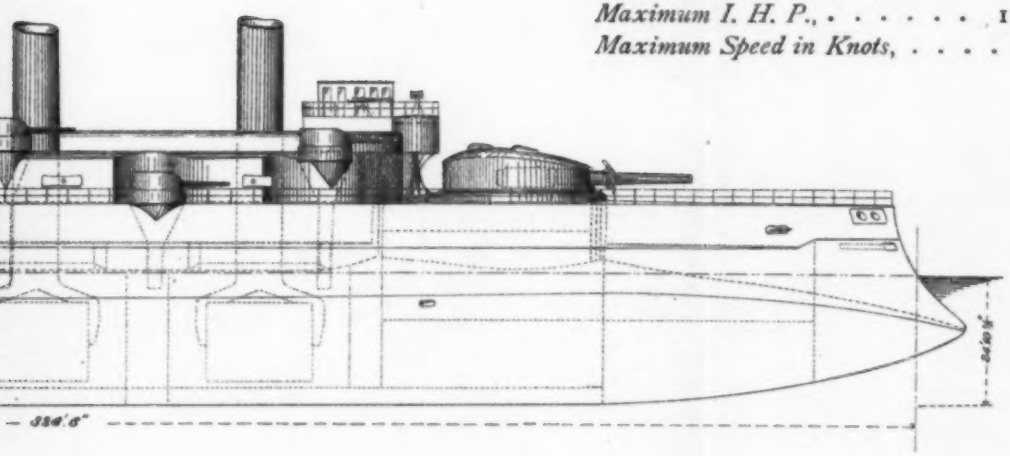
TYPE PLAN.

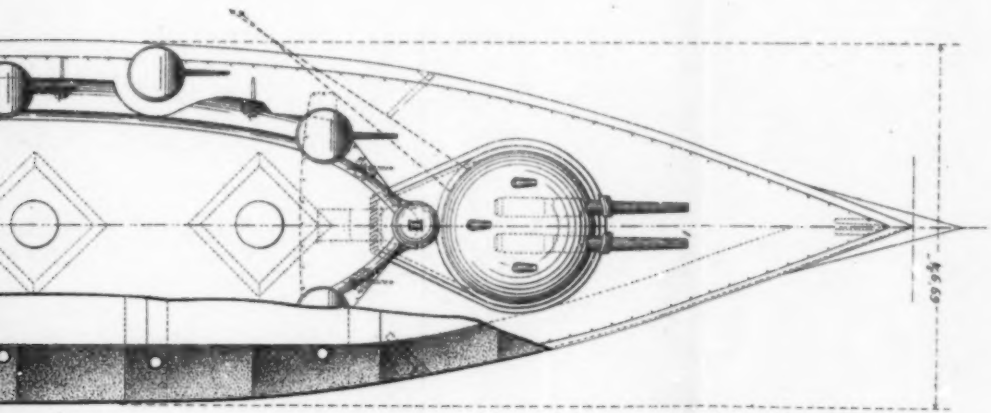
FIRST CLASS BATTLE SHIP OF GREAT COAL ENDURANCE.

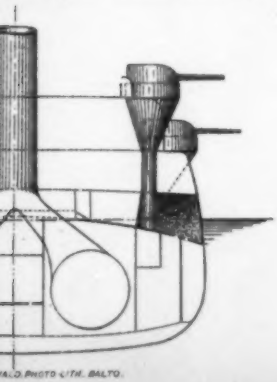


PRINCIPAL DIMENSIONS.

Length between Perpendiculars,	326′ 6″
Beam Extreme,	71′ 6″
Beam on Load Waterline,	69′ 9¾″
Mean Draught,	25′ 4½″
Load Displacement in Tons,	10,000
Maximum I. H. P.,	11,000
Maximum Speed in Knots,	17







ARMAMENT.

4—	12 *inch B. L. R.*
10—	5 *inch R. F. G.*
12—	6 *pounder R. F. G.*
6—	1 *pounder R. F. G.*
2—	37 *mm. R. C.*
6—	*Torpedo Tubes.*

ARMOR.

Thickness of Belt,	5″
Thickness of Armor Deck,	3″
Thickness of Conning Tower (forward)	14″
" " " " *(aft)*	5″
" " *Redoubts,*	16″ + 1½″
" " *Turrets,*	16″ + 1½″
" " *Barbettes to 5″ Guns,*	3″

stances under which such work may have to be done are very uncertain, some latitude must be allowed in this respect.

Plans.—The plans include only the features peculiar to the type, and are not filled in as to details of subdivision, equipment, etc.

TABLE A.

Type of ship.	Load displacement in tons.	Performance.						Estimated endurance.			
		Forced draught.		Full sea power with air pressure of one-half inch of water in fire-rooms.		Natural draught.		At 10 knots on coal carried at load draught.	Total at 10 knots	Total at most economical speed.	Total at full sea power.
		I. H. P.	Speed	I. H. P.	Speed	I. H. P.	Speed				
First-class battle-ship of great endurance	10,000	11,000	17.0	8,250	15.7	7,070	15.0	5400	10,800	13,000	2300
First-class battle-ship of limited endurance	8,000	7,500	15.8	6,100	15.1	5,225	14.1	2770	4,600	5,200	1100
Second-class battle-ship of limited endurance	7,100	6,750	15.8	5,485	14.9	4,700	14.3	2650	4,600	5,200	1100
Third-class battle-ship of limited endurance	6,000	6,500	15.8	5,280	15.2	4,525	14.5	2550	4,600	5,200	1100
Thin-armored cruiser	6,250	9,600	19.0	7,200	17.9	6,170	16.9	7000	10,700	13,000	2100
7500-ton protected cruiser	7,500	20,250	22.0	15,150	20 8	13,000	20.0	8600	15,000	18 000	2100
5400-ton protected cruiser	5,400	12,000	20.0	9,000	19.0	7,700	18.4	6700	11,200	13,000	1850
Torpedo depot and artificer's ship	5,000	10,750	20.0	8,060	18.9	6,910	18.2	7500	11,200	13,000	2000
Ram	3,500	9,700	20.25	7,270	19.1	6,230	18.5	2000	4,800	5,500	1100

DESIGN OF BATTLE-SHIP OF GREAT COAL ENDURANCE.

Certain recent foreign designs and constructions suffice to show the type of ship having the qualities of attack, defense, endurance, and seaworthiness demanded for the battle-ship, as the term is generally understood. The introduction of shells containing a considerable amount of explosives, such as gun-cotton and melinite, has rendered many of the essential features of most of these vessels highly objectionable, and particularly so in the case of the protection afforded the heavy guns by redoubts entirely above the hull armor, leaving large spaces between the redoubt floors and the armor deck for the most advantageous action of high-explosive shell. To carry the increased weight demanded to continue the great-gun protection down to the hull armor, and otherwise provide for the protection

against high explosives of the numerous guns of the powerful secondary batteries now so justly esteemed, while retaining other qualities the same, requires a very considerable increase of displacement.

Simultaneously with the introduction of high-explosive shell-fire, the value of protection by armor of moderate thickness, as relied on to keep out projectiles entirely, has been depreciated by the development of the forged steel, armor-piercing shell, while a new value has been given to thin armor of 4 to 6 inches in causing the explosion before penetration of shell containing high explosives, and incidentally affording a measure of protection against the largely increased volume of fire of small caliber. There is this difference, however, that whereas complete protection was expected of thick armor, accordingly worked below the armor deck, the thin armor is worked entirely above such decks, the chief protection against armor-piercing shell being afforded by thick submerged decks, with water-excluding material above them to insure buoyancy and stability when the thin armor is pierced. As the armor-piercing shell can carry but a small amount of explosive of any kind, it will not mine out any large quantity of such material.

A limit to the vertical extent of thin armor is imposed by the consideration that it should be only so high on the side that an armor-piercing shell which has entered on one side and been deflected by the armor deck should leave the off side above the thin armor, otherwise the tumbling shell with reduced velocity might carry out a large area of the resisting side. It may be remarked that the thin armor of casemates above thick armor belts is specially subject to this risk, except that the armor deck is much less liable to be struck at all, the majority of armor-piercing shell being relied on to go through both sides cleanly.

The armor-piercing shell then has depreciated armor of moderate thickness as commonly worked, and demands considerably increased thickness for the fairly complete protection of the water-line region against penetration by any single projectile, as sought for in the battle-ship of great size.

But this is offset by the influence of high-explosive shell in demanding protection over a greater length of water-line. This has resulted, in the most recent British designs, in retaining the thickness of belt armor at 18 inches over a very much longer belt than formerly.

The general effect of the development of the armor-piercing and high-explosive shells and extension of secondary battery has been to require a very great increase of displacement, with all that is entailed, while increasing the speed but little over the previous designs—and that chiefly by great and perhaps extravagant forcing of the boiler-power—and affording rather inadequate thickness of water-line armor for the increased value of the vessel. Neither is the great-gun protection satisfactory in the vessels of good free-board, being by barbettes, leaving the guns and straps entirely exposed; whereas, when they are protected by turrets, the free-board has to be too low for satisfactory work in a seaway.

To such vessels, then, must be urged the objections of inordinate size (14,000 tons) and cost, excessive draught of water (mean load-draught, 27 feet 6 inches, and extreme, at deep load 30 feet), and unsatisfactory protection of great guns and water-line with sufficient free-board, or of water-line with too low free-board with satisfactory protection of the great guns.

With a view of accomplishing the duty required of this type of war vessel on a much reduced displacement and draught of water (and the draught of the British type is practically prohibited by our harbors), the Board submits a design of somewhat novel character, but free from many of the objections of the British type. Protection to buoyancy and stability is afforded by thin-armored sides with thick submerged deck well covered with water-excluding material, on the principles before laid down.

The great-gun positions are well separated and protected by heavy armored redoubts and turrets, and the numerous 5-inch guns are given complete local protection of considerable thickness. The endurance of coal and all supplies except ammunition exceeds that of any equally powerful ships of this class, and the machinery is of type and size to be economical and reliable. It is believed that to obtain equally satisfactory results by thick-armor protection to the water-line region will involve about 1200 tons greater displacement with correspondingly increased draught of water and more than correspondingly increased cost.

Following is a general description of the design:

PRINCIPAL DIMENSIONS.

Length over all	349′ 2″
Length on load water-line	340′ 2″
Length between perpendiculars	326′ 6″

Beam extreme*	71′	6″
Beam on load water-line	69′	9¾″
Draught mean	25′	4½″
Displacement in tons	10,000	
Free-board to top of berth-deck plank at side	5′	
Free-board to top of main-deck plank at side	13′	
Maximum indicated horse-power (forced draught)	11,000	
Maximum speed in knots	17	
Metacentric height	5′	
Metacentric height after complete riddling of water-line	2′	6″

HULL AND ITS PROTECTION.

To have a double bottom well fore and aft and to be closely subdivided up to the berth-deck. The engines to be in four compartments, and the boilers in four compartments, the latter separated across the middle line by longitudinal bulkheads containing the magazines for fixed ammunition, with complete passage above and below throughout boiler and engine spaces, narrowed in wake of the engines. Longitudinal wing-bunkers along the boilers and engines to contain fore-and-aft passages communicating with the middle-line passage, and the hand-up of 5-inch ammunition to be through the thick tubes opening into these wing passages. There are thus eight longitudinal skins or bulkheads throughout the machinery spaces, and close transverse subdivision. Similarly close subdivision to be carried to the ends of the ship so far as the stowage, etc., will permit. Protection against water-line damage to be afforded by a wide belt of 5-inch armor extending the whole length of the vessel from a maximum depth of five feet below the load water-line to the under side of the berth-deck, 4 feet 9 inches above it, raised forward to include the bow torpedo-tubes. From the lower edge of this armor a 3-inch armor-deck shall extend from side to side, arched as shown on the plan and domed up in wake of the redoubts. Glacis to be worked around the junction with redoubt armor, and also to boiler-hatches, as shown. These and the engine and ventilating hatches to be continued to the berth-deck by plating of about 1½-inch thickness, and armor gratings to be fitted in the openings in the armor-deck. A belt of woodite to extend along the side, between the armor and berth decks the whole length of the ship, to be 12 feet thick at the water-line amidships and 8 feet at the ends, as shown on

* To accomplish a reduction in draught a special form has been given this vessel, involving less beam on the water-line than below it.

the plans. The woodite on each side to be in compartments outboard of a water-tight sloping fore-and-aft bulkhead. Fuel to be stowed over the deck between these bulkheads, the subdivision in these parts being transverse only, and as shown in plan.

CONNING TOWERS.

Two conning towers to be carried. The forward one to be circular, 6 feet 11 inches internal diameter, walls 5 feet 8 inches high and 14 inches thick, crown 2 inches, and base 1½ inches. To stand on a circular armored shaft from rear of redoubt, 8 feet outside diameter and 7 inches thick. The after conning tower to be circular, but only 5 inches thick, with three-fourths of an inch crown, and supported by a 3-inch circular shaft, 6 feet 6 inches outside diameter.

Both towers to be entered by shafts from below, and the shaft to afford an armored hatch to superstructure deck for hand up of fixed ammunition.

MAIN ARMAMENT AND PROTECTION.

The great-gun positions to be two in number, one forward and one aft in the middle line. Each position to be for two 12-inch, 50-ton, breech-loading rifles in turrets, with complete train around bow and stern, respectively, to well forward and abaft the beam as shown. Height of horizontal axis of gun above water-line, 18 feet.

Turrets to be 22 feet inside diameter with armor of 16 inches on backing of 6 inches, with plating behind armor of 1½ inches, stiffened by vertical frames and inner mantlet of $\frac{7}{16}$ inch. Turret crown 2½ inches, with three sighting hoods, and hatch with armor grating. Aprons of 3 inches carried on guns over ports.

Turrets to stand on and in armored redoubts as shown. Thickness of redoubt armor, 16 inches, tapering to a minimum of 11 inches behind the 5-inch armor belt. The armor on backing of 6 inches, with plating behind armor of 1½ inches, with 12-inch stiffeners and 17½ pounds mantlet. Stiffeners and mantlet omitted to armor of rear. Thickness of crown of rear of redoubt 2½ inches. The armor to be worked in two widths, except to rear, joining at platform within redoubt. Turret and redoubt supports to include magazines and shell-rooms for main battery.

Guns to load in a single fore-and-aft position, elevated and run in. Eighty rounds to be carried for each gun at load displacement.

SECONDARY BATTERY AND ITS PROTECTION.

Between the great-gun positions, a central superstructure to extend as shown on the plans. Ten 5-inch rapid-firing guns to be carried on main and superstructure decks as shown in low 3-inch barbettes, with complete shields of 3 inches or equivalent over the gun and turning with it, the barbettes to extend to the wing-passages below armor-deck by cone and tube bases; cones and tubes above berth-deck 2 inches thick, and tubes below berth-deck 1 inch thick. All as before described.

Twelve 6-pounder, rapid-firing guns to be carried, eight within the superstructure and four on bridges above the conning towers.

Allowance is made for thick plating and shields for these guns. Six 1-pounder, rapid-firing guns to be carried, four as against boat attack on the berth-deck and two in the tops.

Two 37-millimeter, revolving cannon to be carried in the tops.

The ammunition allowance is as follows: One hundred and fifty rounds for each 5-inch, rapid-firing gun; 400 rounds for each 6-pounder, rapid-firing gun; 700 rounds for each 1-pounder, rapid-firing gun; 1500 rounds for each 37-millimeter, revolving cannon.

TORPEDO OUTFIT.

To consist of six tubes—two fixed above water behind the 5-inch armor in the bows, and four under water in the sides near great-gun positions.

MOTIVE POWER.

Boilers.—Under forced draught to supply steam of 160 pounds for main engines and auxiliaries.

The main boilers are four in number, 15 feet 2 inches diameter and 20 feet long, of double-end type, with eight furnaces and separate combustion chambers. Each pair of boilers to be served by one stack. Aggregate heating surface, 21,500 square feet. Corresponding indicated horse-power at 1.8 square feet, 11,945 indicated horse-power.

A donkey boiler to be carried on the armor deck; to have 30 square feet of grate and about 950 square feet of heating surface.

Engines.—To be four in number, two on each shaft. Two to be of the vertical three-cylinder, triple-expansion type. Cylinders 30½, 45, and 68 inches diameter; stroke, 39 inches. Revolutions per minute, 93¾ at maximum speed of 17 knots. Corresponding piston speed, 609 feet per minute.

COAL ENDURANCE.

The coal carried at load draught is 675 tons, and total coal capacity is estimated at 1350 tons. On the coal at load draught the steaming distance at 10 knots is 5400 knots. With full bunkers at 10 knots, 10,800 knots; and at most economical speed of about 8 knots, about 13,000 knots. The steaming distance at full sea power and speed of 15.7 knots is 2300 knots.

EQUIPMENT AND OUTFIT.

A single military mast is carried, with two tops. Eleven boats are carried and two 60-foot torpedo-boats. The boats are chiefly handled by derrick on mast. Provision is made for defense by torpedo nets and booms. The complement of officers and men is fixed at five hundred.

TABLE OF WEIGHTS AND DISTRIBUTION OF DISPLACEMENT.

The statement of weights and their distribution among the various elements of efficiency is as follows:

	Tons.
Hull proper and fittings	3,050
Hull protection (5-inch side armor, 620; 3-inch armor deck with glacis and hatches, 910; water-excluding material, 270)	1,800
Conning towers with armored shafts and connections	90
Two great-gun positions (turret and guns, 430; redoubt, 525; ammunition and equipment, 105 = 1060)	2,120
Secondary battery, gatlings, and small arms, with ammunition, torpedo outfit, and search lights (242), and protection (212)	454
Propelling machinery, donkey, and spare parts and stores	1,215
Hydraulic and auxiliary machinery, including electric lighting and dynamos	100
Coal at load displacement	675
Equipment and outfit	500
Total weight and displacement	10,004

ESTIMATED COST.

The elements of cost are itemized as follows:

Hull and armor	$3,515,000
Propelling and auxiliary machinery, including donkey boiler and spare parts	1,050,000
Ordnance and torpedo outfit	850,000
Equipment outfit and stores	225,000
Estimated total cost	$5,640,000

BATTLE-SHIPS OF LIMITED COAL ENDURANCE.

It has been hereinbefore demonstrated that the most important and immediate area of naval action, in the event of war with the European nations most powerful on the sea, is included within a line drawn a thousand miles from the Atlantic coast, and extending from the Gulf of St. Lawrence on the north, to the Windward Islands and the Isthmus on the south.

To destroy at the outset all bases of supply and maintain our complete supremacy within this area would insure a comparatively perfect defense of the Atlantic coast and its trade. In addition, to provide for the raids of swift cruisers and the concentrated attack of an enemy's squadron at specially important points, after evading our cruiser scouts, demands a force localized and adapted to local requirements, and yet capable of rapid concentration. Thus a few suitable guard-ships would suffice for the complete protection of an important point against any small force of cruisers, and, in conjunction with fortifications, mines, and torpedo-boats, would prevent bombardment until, by the rapid concentration of a powerful force of our own from adjacent points, the investing squadron could be attacked in force and to great advantage.

To perform this duty, a type of vessel is required of great fighting power and adequate protection, able to take the sea without regard to weather, and fight her guns at sea with the ordinary battle-ships, possessing considerable sea speed, and of draught suitable for comfortable work in our harbors and their approaches. The endurance of all supplies may be limited, and the coal supply should be sufficient for independent action within about 1000 miles, and therefore for a total endurance of not less than about 3000 miles.

Three types of vessels have been designed to meet these requirements, alike in all essentials except great-gun power and draught of water, and differing slightly in protection. All have a maximum speed of 15¼ knots and a sea speed of about 15 knots, with a coal endurance of 4600 knots at 10 knots, and 5200 knots at most economical speed, while at full sea speed they can steam 1100 knots.

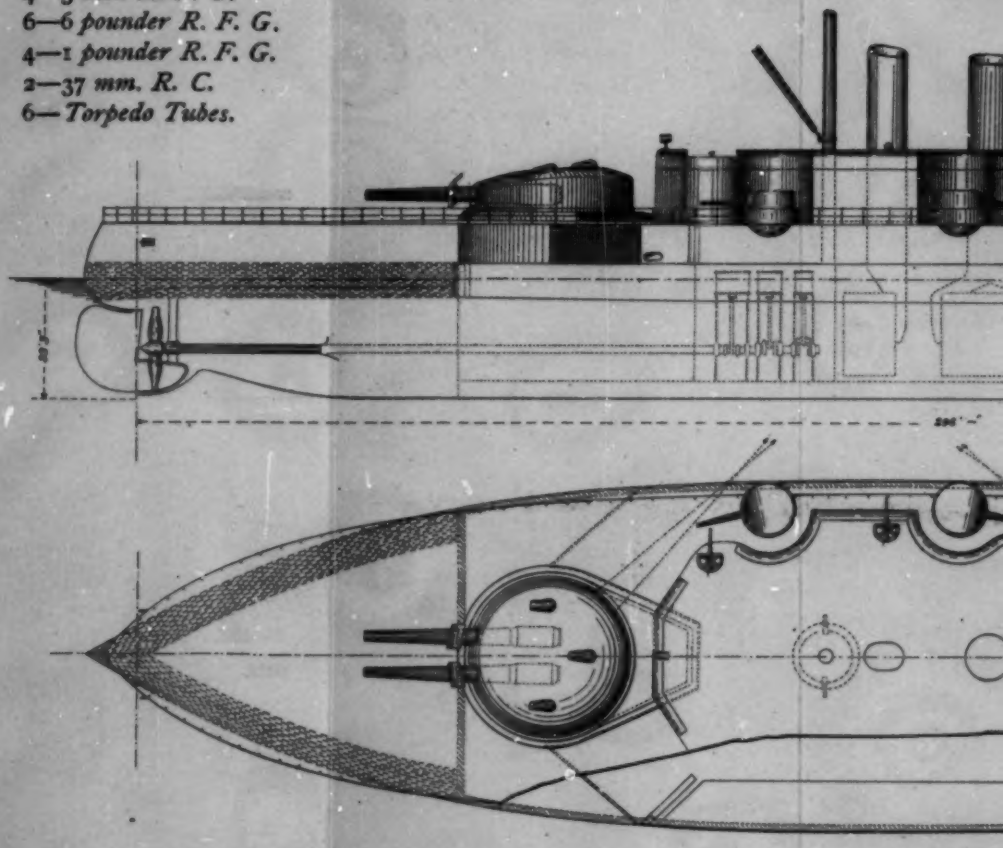
Their arrangements are similar, except that the smaller type has a preponderance of bow over stern fire, and her after great guns are mounted in barbette, while the others are in turrets. All are mounted in the middle line, and between the two great-gun positions is a central superstructure and a secondary battery, practically alike for all.

TYPE PLAN

FIRST CLASS BATTLE SHIP OF LIMIT

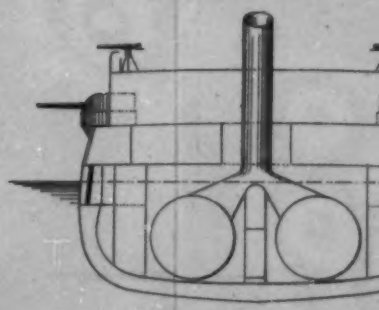
ARMAMENT.

4—13 inch B. L. R.
4—5 inch R. F. G.
6—6 pounder R. F. G.
4—1 pounder R. F. G.
2—37 mm. R. C.
6—Torpedo Tubes.



PRINCIPAL DIMENSIONS.

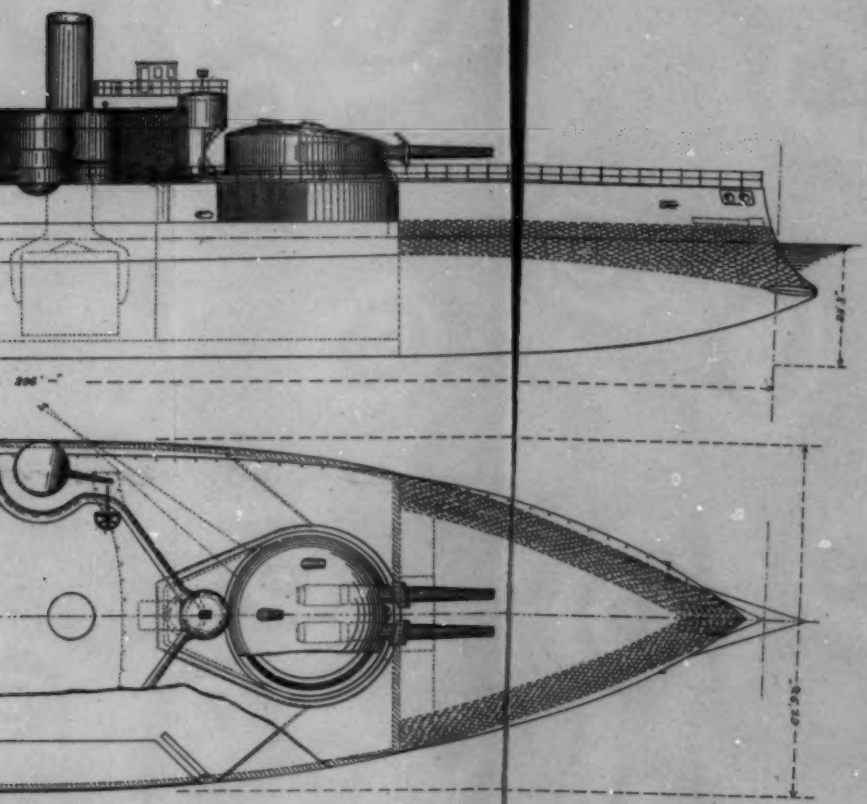
Length between Perpendiculars, 296'—"
Beam Extreme, ... 67' 9½"
Mean Draught, ... 23' 3"
Load Displacement in Tons, . . . 8000
Maximum I. H. P., ... 7500
Maximum Speed in Knots, . . . 15.8

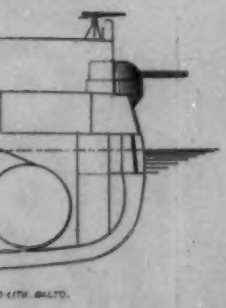


BOSC FRIEDERWALD, PHOTO-LITH. BALTO.

LAN.

LIMITED COAL ENDURANCE.





ARMOR.

Length of Belt,	. . . . .	164′—″
Thickness of Belt,	. . . . .	17″ + 2″
"	*Armor Bulkheads,*	14″ + 1½″
"	*Casemate,*	4″ *and* 5″
"	*Redoubts,* . . .	17″ + 1½″
"	*Turrets,*	17″ + 1½″
"	*Armor Deck,* . .	2½″ *and* 3″
"	*Conning Tower,*	14″

To face page 233.

Hull protection is afforded by belts of heavy armor of length exceeding one-half the length of the ship, terminating in athwartships bulkheads, the whole including about 72½ per cent of the water-line area. Over the belt and forward and abaft the bulkheads, heavy armor decks are worked, associated with wing coal bunkers over the belt, and wing belts of water-excluding material forward and aft. An additional feature of the protection is a casemate of 4-inch armor extending above the belt between the gun positions for about one-third the length of the ship on the side.

This arrangement of protective material is not considered as necessarily the best or only suitable one. For instance, a preferable arrangement in some respects would be to shorten the belts of thick armor, and terminate it in oblique triangular bulkheads, dispense with the casemate, giving local protection to the supports of 5-inch guns, etc., and continue in the water-line protection to the ends of the ship with thin armor as in the design of battle-ship of great endurance. The present arrangement was adopted as being in greater general accordance with former and recent foreign designs, and perhaps less questionable than the alternative suggested.

The first type of these vessels is of 8000 tons displacement, and 23 feet 3 inches mean load draught, mounting four 13-inch (60-ton) breech-loading rifles in turrets, with thick armor protection of 17 inches.

The second type is of 7100 tons displacement, and 22 feet 6 inches mean load draught, mounting four 12-inch (50-ton) breech-loading rifles in turrets, with thick armor protection of 16 inches.

The third type is of 6000 tons displacement, and 21 feet mean load draught, mounting two 12-inch (50-ton) breech-loading rifles forward in turret, and two 10-inch (26-ton) breech-loading rifles aft in barbette. Thick armor protection of hull and 12-inch guns, 15 inches; of 10-inch guns, 12½ inches.

Having the same speed, endurance, and general qualities, they are specially well adapted to act together in squadron.

DESIGN OF FIRST-CLASS BATTLE-SHIP OF LIMITED COAL ENDURANCE.

Principal Dimensions.

Length over all	314′ 0″
Length on load water-line	306′ 0″
Length between perpendiculars	296′ 0″

Beam extreme	67′ 9½″
Mean draught	23′ 3″
Displacement in tons	8000
Free-board to top of berth-deck plank at side	3′ 1″
Free-board to top of main-deck plank at side	10′ 6″
Maximum indicated horse-power (forced draught)	7500
Maximum speed in knots	15.8
Estimated metacentric height	5′ 0″

HULL AND ITS PROTECTION.

To have a double bottom, extending from the armor shelf, from side to side, well fore and aft. The engines to be in two compartments and the boilers in two, separated across the middle line by double longitudinal bulkheads, affording upper and lower passages, and containing the main drainage and pumping systems. Longitudinal coal bunkers extend outboard along the length occupied by boilers and engines. There are thus ten longitudinal skins or bulkheads throughout the machinery spaces, with close transverse subdivision. Similarly close subdivision to be carried to the ends of the ship, so far as the storage, etc., will permit.

Protection against water-line damage to be afforded by a belt of 17-inch armor for a length of 164 feet, extending from a depth of 4 feet 6 inches below the load water-line amidships, and 3 feet 6 inches at the ends, to a uniform height of 2 feet 10 inches above; to terminate in athwartship bulkheads of 14-inch armor. An armor deck of 2½ inches to be worked over the belt, and a submerged deck of 3 inches from the armor bulkheads to the ends of the vessel, with stability wings of water-excluding material to the berth-deck, 6 feet thick at the water-line.

Over the belt amidships, a length of 95 feet on each side between the berth and main decks to be plated with 4 inches, terminating in oblique bulkheads of 5 inches to the redoubts. Wing coal bunkers to extend along the sides of this casemate, and torpedo-tubes to be fitted in the corners.

Glacis to be worked around the junction of armor deck with redoubt armor. All hatches in this deck to have coffer-dams filled with cellulose to a height of 3 feet.

The decks to have no sheer. Crown of armor deck over belt, 3 inches; of main deck, 9 inches. Clear height of between decks at side, 6 feet 3½ inches; amidships, 6 feet 9½ inches.

CONNING TOWER.

A conning tower to be carried on the superstructure forward; to be circular in plan, 6 feet 11 inches internal diameter, armor 5 feet 8 inches high and 14 inches thick, crown 2 inches, and base 1½ inches.

To stand on a circular armored shaft from rear of forward redoubt, 8 feet outside diameter, and 7 inches thick.

The tower to be entered by the shaft from below, and the shaft also to afford an armored hatch to superstructure deck for hand-up of fixed ammunition.

MAIN ARMAMENT AND ITS PROTECTION.

The great-gun positions to be two in number, one forward and one aft, in the middle line. Each position to be for two 13-inch 60-ton breech-loading rifles in turrets, with complete train around bow and stern to well abaft and forward the beam respectively as shown. Height of horizontal axis of guns above water-line, 16 feet.

Turrets to be 24 feet internal diameter, with armor of 17 inches, worked on backing of 6 inches, with plating behind armor of 1½ inches, stiffened by vertical frames and with inner mantlets of $\frac{7}{16}$ inch. Turret crown, 2½ inches, with three sighting-hoods and hatch with armor gratings. Deflective aprons of 3 inches carried on guns in front of the ports.

The turrets to stand over and in armored redoubts which extend to the armor deck. The thickness of armor on the redoubt to be 17 inches, except where protected by the casemate of thin armor, where it is to be 12½ inches. The armor to be worked on backing 6 inches thick; the plating behind to be 1½ inches, stiffened by vertical frames, and with an inner mantlet of $\frac{7}{16}$ inch.

The stiffeners and mantlet to be omitted at the rear of the redoubt in wake of the loading apparatus; the sloping crown over the rear of the redoubt to be 2 inches thick.

The turret and redoubt supports to include magazines and shell-rooms for main battery.

The guns to load in a single fore-and-aft position, elevated and run in.

The ammunition supply for each 13-inch gun to be forty-five rounds at load displacement.

SECONDARY BATTERY AND ITS PROTECTION.

Between the great-gun positions a central superstructure to extend as shown on the plans. Four 5-inch guns to be carried on the upper

deck in low barbettes of 3-inch thickness, and with shields over guns of 3 inches, or the equivalent, which turn with the guns.

The smaller guns of the secondary battery to be six 6-pounder rapid-firing guns, four 1-pounder rapid-firing guns, two 37-millimeter revolving cannon.

The 6-pounder guns are carried on the superstructure deck, and protected by shields on the guns.

The 1-pounder guns are carried on the berth deck, being intended primarily for defense against torpedo-boat attacks by night, and are protected by extra thick plating in wake of their ports and small shields on the guns.

The revolving cannon are carried in the fighting top, and are to have a train of 360° each.

The ammunition allowances are as below:

	Rounds.
For each 5-inch rapid-firing gun	120
For each 6-pounder rapid-firing gun	300
For each 1-pounder rapid-firing gun	600
For each 37-millimeter revolving cannon	1200

TORPEDO OUTFIT.

To consist of six tubes above water, two fixed at the bow, diverging at 5 degrees and to be worked simultaneously, and four training at corners of casemate. Twelve torpedoes to be carried.

EQUIPMENT AND OUTFIT.

A single military mast is fitted with one fighting-top. A derrick to be fitted for handling boats. The supply of boats and rafts to be only sufficient for the ordinary service of the ship and for life-saving purposes.

The complement, officers and men, is fixed at three hundred and fifteen.

MOTIVE POWER.

Boilers.—Under forced draught to supply steam of 160 pounds pressure for main engines and auxiliaries.

The main boilers to be four in number. Two of them to be 16 feet in diameter and 18 feet 6 inches long, double-ended, with eight furnaces and a common combustion chamber. Two of them to be 16 feet in diameter and 10 feet long, single-ended, with four furnaces and a common combustion chamber.

The boilers to be arranged in two water-tight compartments, one on either side of the middle line, the double-ended boiler forward and the single-ended boiler aft in each boiler-room.

The aggregate heating surface of main boilers to be about 16,600 square feet, and the corresponding indicated horse-power required of main and auxiliary engines, 8500.

Engines.—The main propelling engines to be two in number, one on each shaft, and of the vertical, three-cylinder, triple-expansion type. Cylinders to be 33½, 50½, and 75½ inches in diameter, respectively, and the stroke, 43 inches.

The revolutions corresponding to the proposed maximum speed of 15.8 knots to be ninety-four per minute, when it is expected that the main engines will develop about 7500 indicated horse-power. The piston speed at the proposed maximum revolutions will be 674 feet per minute.

COAL ENDURANCE.

The coal supply at load draught is 300 tons, and the total coal capacity is estimated at 500 tons. On the coal at load draught the steaming distance at 10 knots is 2770 miles. On the total coal capacity the steaming distance at 10 knots is 4600 miles. At full sea speed of 15.1 knots the steaming distance on the total coal capacity is 1100 miles.

ASSIGNMENT OF WEIGHTS.

		Tons.
Hull proper and fittings		2,200
Hull protection:		
Belt armor	1,122	
Deck armor and glacis	673	
Casemate armor	168	
Water-excluding material	53	
		2,016
Conning tower and armored shaft		70
Two great-gun positions—Turret and guns, 534; redoubt, 393; ammunition and equipment, 78—each 1,005, equal		2,010
Secondary battery, gatlings, and small arms, with ammunition, torpedo outfit, and search lights (109), and protection (51)		160
Propelling machinery, with stores and spare parts		865
Auxiliary machinery, including electric lights outfit		110
Coal at load displacement		300
Equipment and outfit		298
Total		8,000

ESTIMATED COST.

Hull and armor	$3,318,650
Propelling and auxiliary machinery	717,350
Ordnance and torpedo outfit	862,500
Equipment outfit and stores	88,000
Total cost	$4,986,500

SECOND-CLASS BATTLE-SHIP OF LIMITED COAL ENDURANCE, ETC.

[No plans are furnished for this ship, which is to be precisely similar in type to the first-class battle-ship of 8000 tons.]

Length over all	308′	0″
Length on load water-line	300′	0″
Length between perpendiculars	290′	0″
Beam extreme	64′	6″
Mean draught	22′	6″
Displacement in tons	7100	
Free-board to top of berth-deck plank at side	3′	0″
Free-board to top of main-deck plank at side	10′	4″
Maximum indicated horse-power (forced draught)	6750	
Maximum speed in knots	15.8	
Estimated metacentric height	4′	6″

HULL AND ITS PROTECTION.

To have a double bottom running well fore and aft, and extending to the armor shelf on each side. The engines to be in two compartments, and the boilers in two, separated across the middle line by double longitudinal bulkheads, affording upper and lower passages and containing the main drainage and pumping systems.

Longitudinal coal bunkers extend outboard along the length occupied by boilers and engines.

There are thus ten longitudinal skins or bulkheads throughout the machinery spaces, with close transverse subdivision. Similarly close subdivision to be carried to the ends of the ship, so far as the requirements of storage, etc., will permit.

Protection against water-line damage to be afforded by a belt of 16-inch armor for a length of 160 feet amidships, extending from a depth of 4 feet 6 inches below the water-line amidships, and 3 feet 6 inches below the water-line at the ends, to a uniform height of 2 feet 8 inches above the water-line. To terminate in athwartship bulkheads of 14-inch armor. An armor deck 2½ inches thick to be worked over the belt, and submerged armor decks of 2½ inches to be worked from the armor bulkheads to the ends of the vessel, with stability wings of water-excluding material extending from the submerged deck to the berth deck. These to be 6 feet thick on each side. Over the belt amidships, for a mean length of 90 feet on each side, between the berth and main decks, to be plated with 4-inch armor, terminating in oblique bulkheads to the redoubts 4 inches

thick. Wing coal bunkers to extend along the sides of this armored casement, and a torpedo-tube to be fitted in each corner where the diagonal bulkheads join the sides.

Glacis to be worked around the junction of the armor deck with the redoubt armor. All hatches in this deck to have coffer-dams filled with cellulose to a height of 3 feet.

The decks to have no sheer. Crown of armor deck over belt, 3 inches, of main or upper deck, 9 inches. Clear height of between decks at side, 6 feet 3½ inches, and amidships, 6 feet 9½ inches.

CONNING TOWER.

A conning tower to be carried on the superstructure forward. To be circular in plan, 6 feet 11 inches in diameter inside. The walls to be 5 feet 8 inches high and 13 inches thick. The crown to be 1½ inches, and the base-plate, 1½ inches. To stand on a circular armored shaft from rear of forward redoubt, 7 feet 9 inches in external diameter and 6½ inches thick.

The tower to be entered by the shaft from below, and the shaft also to afford an armored hatch to the superstructure deck for the passage of fixed ammunition.

MAIN ARMAMENT AND ITS PROTECTION.

The great-gun positions to be two in number, one forward and one aft, in the middle line.

Each position to be for two 12-inch 50-ton breech-loading rifles, with complete train around bow and stern, respectively, to well abaft and forward the beam, as in the 8000-ton battle-ship.

The height of the horizontal axis of the guns above the water-line to be 15 feet 3 inches.

The turrets to be 22 feet 6 inches internal diameter, with armor of 16 inches worked on wood backing 6 inches thick, and plating behind, 1½ inches thick. The latter is stiffened by vertical frames, and inside of all is a mantlet $\frac{7}{16}$ inch thick. The crown of the turrets is 2½ inches thick, with three sighting-hoods and hatch with armor gratings. Deflective aprons of 3 inches to be carried on the guns in front of the ports.

The turrets to stand over and in armored redoubts which extend to the armored deck. The thickness of armor on redoubts to be 16 inches, except where protected by the casemate of thin armor, where it is to be 12 inches. In the extreme rear the redoubt is to have but 10 inches of armor.

The redoubt armor is to be worked on 6-inch backing; the plating behind to be 1½ inches, stiffened by vertical frames, and with an inner mantlet of $\frac{7}{16}$ inch.

The stiffeners and mantlet to be omitted at the rear of the redoubt in wake of the loading apparatus. The sloping crown over the rear of the redoubt to be 2 inches thick.

The turret and redoubt supports to include magazines and shell rooms for the main battery.

The guns to load in a single fore-and-aft position, elevated and run in.

The ammunition supply for each 12-inch gun to be forty-five rounds at load displacement.

THE SECONDARY BATTERY AND ITS PROTECTION.

Between the great-gun positions a central superstructure to extend as shown on the plans. Four 5-inch guns to be carried on the upper deck in low barbettes of 3 inches thickness, and with shields over the guns of 3 inches thickness or the equivalent, which are to turn with the guns.

The smaller guns of the secondary battery to be four 6-pounder rapid-firing guns, ten 1-pounder rapid-firing guns, and two 37-millimeter revolving cannon.

The 6-pounder guns to be carried on the superstructure deck, and protected by shields on the guns.

Four of the 1-pounder guns to be carried on the berth deck, being intended primarily for defense against torpedo-boat attack by night, and to be protected by extra thick plating in wake of their ports, and small shields on the guns.

The remainder of the 1-pounder guns to be carried on the superstructure deck, and protected by small shields on the guns.

The revolving cannon to be carried in the fighting-top, and to have a train of 360° each.

The ammunition allowances are as below:

	Rounds.
For each 5-inch rapid-firing gun	120
For each 6-pounder rapid-firing gun	300
For each 1-pounder rapid-firing gun	600
For each 37-millimeter revolving cannon	1200

TORPEDO OUTFIT.

To consist of six tubes above water, two fixed at the bow, diverging at 5 degrees, and to be worked simultaneously, and four training

at the corners of the armored casemate. There are to be twelve torpedoes carried.

EQUIPMENT AND OUTFIT.

A single military mast, to be fitted with one top. A derrick to be fitted for handling boats. The supply of boats and life-rafts to be only sufficient for the ordinary service of the ship and for life-saving purposes.

The complement, officers and men, is fixed at three hundred and ten.

MOTIVE POWER.

Boilers.—Under forced draught to supply steam of 160 pounds pressure for main engines and auxiliaries. The main boilers to be four in number. Two of them to be 15 feet 4 inches in diameter by 18 feet 6 inches long, double-ended, with eight furnaces and a common combustion chamber. Two of them to be 15 feet 4 inches in diameter by 10 feet long, single-ended, with four furnaces and a common combustion chamber. The boilers to be arranged in two water-tight compartments, one on either side of the middle line, the double-ended boiler forward and the single-ended boiler aft in each boiler-room.

The aggregate heating surface of main boilers to be about 15,100 square feet, and the corresponding indicated horse-power required of main and auxiliary engines, 7750.

Engines.—The main engines to be two in number, one on each shaft, and of the vertical, three-cylinder, triple-expansion type. The cylinders to be 32, 48, and 71½ inches in diameter, respectively, and the stroke, 41 inches. The revolutions, corresponding to the proposed maximum speed of 15.8 knots, to be ninety-nine and one-quarter per minute, when it is expected that the main engines will develop about 6750 indicated horse-power. The piston speed at the proposed maximum revolutions will be 678 feet per minute.

COAL ENDURANCE.

The coal supply at load draught to be 265 tons, and the total coal capacity is estimated at 460 tons. On the coal at load draught the steaming distance at 10 knots is 2650 miles. On the total coal capacity the steaming distance at 10 knots is 4600 miles. At full sea speed of 14.9 knots the steaming distance on the total coal capacity is 1100 miles.

ASSIGNMENT OF WEIGHTS.

		Tons.
Hull proper and fittings		1,976
Hull protection:		
Belt	1,024	
Deck armor and glacis	620	
Casemate armor	148	
Water-excluding material	52	
		1,844
Conning tower and armored shaft		62
Two great-gun positions: Turret and guns, 433; redoubt, 350; ammunition and equipment, 62 = 845		1,690
Secondary battery, gatlings, and small arms, with ammunition, torpedo outfit, and search-lights (108), and protection (50)		158
Propelling machinery, with stores and spare parts		775
Auxiliary machinery, including electric lighting		85
Coal at load displacement		265
Equipment and outfit		252
Total		7,107

ESTIMATED COST.

Hull and armor	$2,950,000
Propelling and auxiliary machinery	640,000
Ordnance and torpedo outfit	700,000
Equipment outfit and stores	85,000
Total	$4,375,000

THIRD-CLASS BATTLE-SHIP OF LIMITED COAL ENDURANCE.

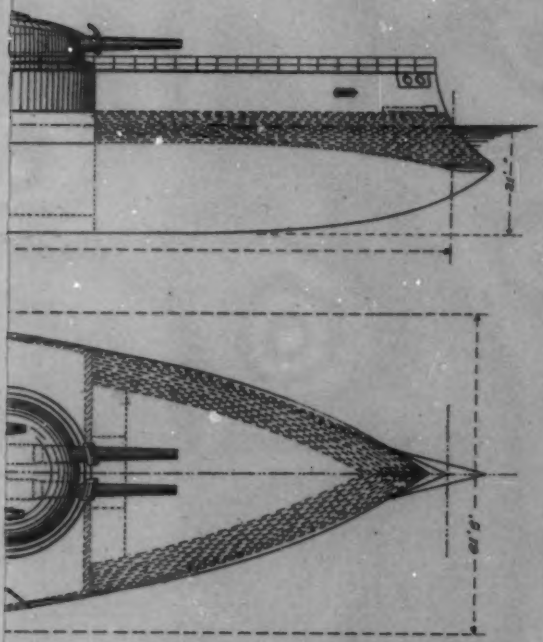
Principal Dimensions, etc.

Length over all	298′ 0″
Length on load water-line	290′ 0″
Length between perpendiculars	280′ 0″
Beam extreme	61′ 6″
Mean draught	21′ 0″
Displacement in tons	6000
Free-board to top of berth-deck plank at side	2′ 9″
Free-board to top of main-deck plank at side	10′ 2″
Maximum indicated horse-power (forced draught)	6500
Maximum speed in knots	15.8
Estimated metacentric height	4′.8

HULL AND ITS PROTECTION.

To have a double bottom running well fore and aft, and extending to the armor shelf on each side. The engines to be in two compartments,

URANCE.



ARMOR.

Length of Belt, ...	155'—"
Thickness of Belt, ...	15" + 1½"
" " *Bulkheads*, . .	13" + 1½"
" " *Casemate*, ...	4"
" " *Redoubts*, . .	15" + 1½"
" " *Barbette*, .	12½" + 1½"
" " *Conning Tower*, . .	12"
" " *Armor Deck*,	2½" *and* 2½"

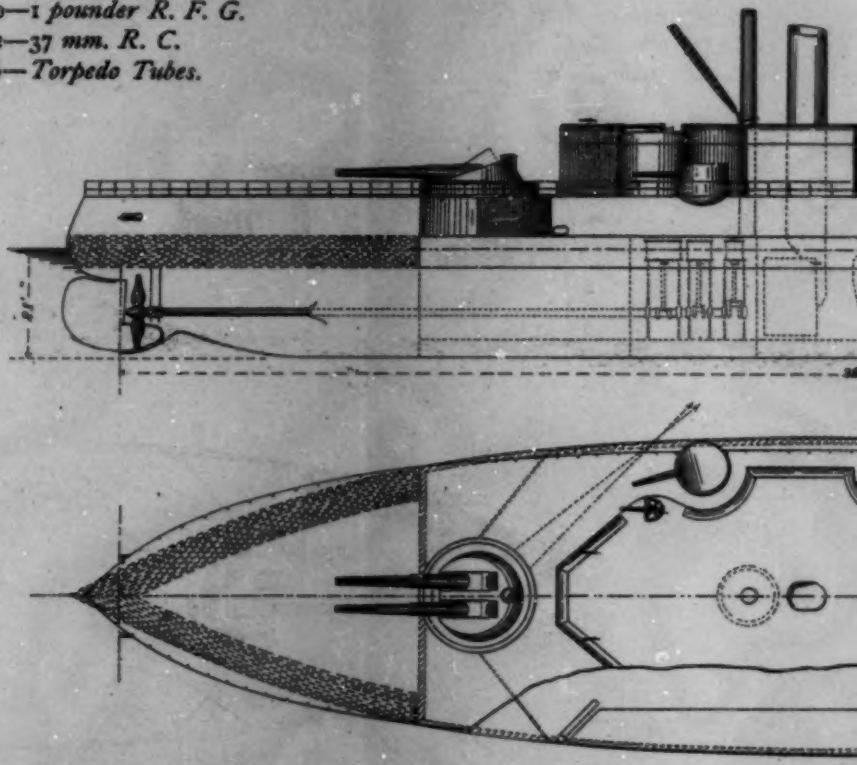
To face page 243.

TYPE

THIRD CLASS BATTLE SHIP OF

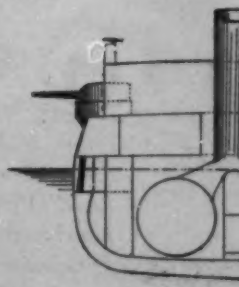
ARMAMENT.

2—12 *inch B. L. R.*
2—10 *inch B. L. R.*
4—5 *inch R. F. G.*
4—6 *pounder R F. G.*
10—1 *pounder R. F. G.*
2—37 *mm. R. C.*
6—*Torpedo Tubes.*



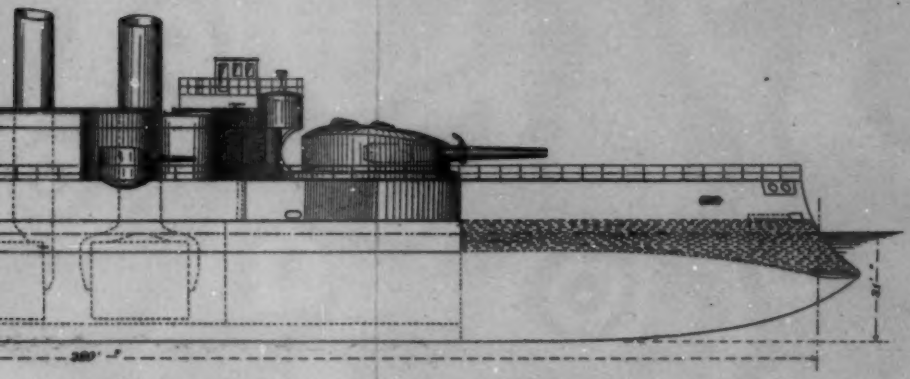
PRINCIPAL DIMENSIONS.

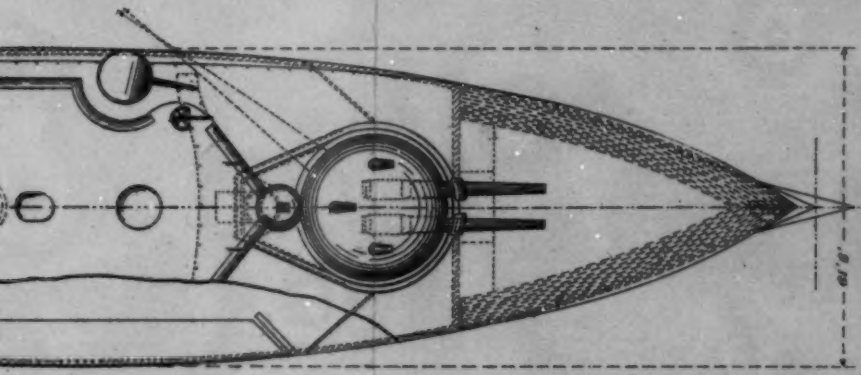
Length between Perpendiculars,	280′—″
Beam Extreme,	61′ 6 ″
Mean Draught,	21′ 6 ″
Load Displacement in Tons,	6000
Maximum I. H. P.,	6500
Maximum Speed in Knots,	15.8

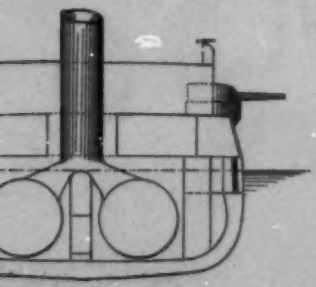


PE PLAN.

IP OF LIMITED COAL ENDURANCE.







ARMOR.

Length of Belt,	155′—″
Thickness of Belt,	15″ + 1½″
" " *Bulkheads,*	13″ + 1½″
" " *Casemate,*	4″
" " *Redoubts,*	15″ + 1½″
" " *Barbette,*	12½″ + 1½″
" " *Conning Tower,*	12″
" " *Armor Deck,*	2½″ and 2½″

To face page 243.

.L END

and the boilers in two, separated across the middle line by double longitudinal bulkheads, affording upper and lower passages, and containing the main drainage and pumping systems.

Longitudinal coal bunkers extend outboard along the length occupied by boilers and engines.

There are thus ten longitudinal skins or bulkheads throughout the machinery spaces, with close transverse subdivision.

Similarly close subdivisions to be carried to the ends of the ship, so far as the requirements of stowage, etc., will permit.

Protection against water-line damage to be afforded by a belt of 15-inch armor for a length of 155 feet amidships, extending from a depth of 4 feet 6 inches below the water-line amidships, and 3 feet 6 inches below the water-line at the ends to a uniform height of 2 feet 6 inches above water-line. To terminate in athwartship bulkheads of 13-inch armor.

An armor deck 2½ inches thick to be worked over the belt, and submerged armor decks of 2¾ inches to be worked from the armor bulkheads to the ends of the vessel, with stability wings of water-excluding material extending from the submerged deck to the berth deck. These to be 6 feet thick on each side.

Over the belt amidships, for a mean length of 100 feet, on each side, between the berth and main decks, to be plated with 4-inch armor, terminating in oblique bulkheads to the redoubts, 4 inches thick. Wing coal bunkers to extend along the sides of this armored casemate, and a torpedo-tube to be fitted in each corner, where the diagonal bulkheads join the sides.

Glacis to be worked around the junction of the armor deck with the redoubt armor. All hatches in this deck to have coffer-dams filled with cellulose to a height of 3 feet. The decks to have no sheer. Crown of armor deck over belt, 3 inches; of main or upper deck, 9 inches. Clear height of between decks at side, 6 feet 3½ inches, and amidships, 6 feet 9½ inches.

CONNING TOWER.

A conning tower to be carried on the superstructure forward. To be circular in plan, 6 feet 11 inches in diameter inside. The walls to be 5 feet 8 inches high and 12 inches thick. The crown to be 1½ inches, and base-plate, 1¼ inches. To stand over a circular armored shaft, from the rear of forward redoubt, 7 feet 9 inches in diameter and 6½ inches thick. The tower to be entered by the shaft from below,

and the shaft also to afford an armored hatch to the superstructure deck for the passage of fixed ammunition.

MAIN ARMAMENT AND ITS PROTECTION.

The great-gun positions to be two in number, one forward and one aft, in the middle line.

The forward position to be for two 12-inch 50-ton breech-loading rifles in a turret, and the after position for two 10-inch 26-ton breech-loading rifles in a barbette.

These guns to have complete train around bow and stern respectively to well abaft and forward the beam, as shown.

The height of the horizontal axis of the forward guns above the water-line is 14 feet 6 inches, and of the after guns is 13 feet 6 inches. The turret to be 22 feet 6 inches internal diameter, with armor of 15 inches worked on wood backing 6 inches thick, and plating behind armor 1½ inches thick. The latter is stiffened by vertical frames, and inside of all is a mantlet $\frac{7}{16}$ of an inch thick. The crown of the turret is 2½ inches thick, with three sighting-hoods and hatch with armor gratings. Deflective aprons of 3 inches are carried on the guns in front of the ports.

The turret to stand over and in an armored redoubt which extends to the armor deck. The redoubt armor to be 15 inches thick in front, and 10 inches on sides and rear where protected by the armored casemate.

The redoubt armor is to be worked on 6-inch backing. The plating behind is to be 1½ inches, stiffened by vertical frames, and with an inner mantlet of $\frac{7}{16}$ of an inch. The turret and redoubt supports to include magazine and shell-room for the 12-inch guns.

The 12-inch guns to load in a single fore-and-aft position, elevated and run in. The ammunition supply for each 12-inch gun to be forty-five rounds at load displacement.

The barbette aft to be 17 feet inside diameter, with armor of 12½ inches, suitably diminished where protected by the casemate, worked on 6-inch backing, and 1½-inch plating behind. The latter to be stiffened by vertical framing, and a seven-sixteenth mantlet worked inside of all.

The crown, gun-shields, etc., to be 3 inches thick, or the equivalent, and a suitable working tower is to be fitted.

The guns are to load at any train.

The ammunition supply for each 10-inch gun to be fifty rounds at load displacement.

SECONDARY BATTERY AND ITS PROTECTION.

Between the great-gun positions a central superstructure to extend as shown on the plans. Four 5-inch guns to be carried on the upper deck in low barbettes of 3 inches thickness, and with shields over the guns of 3 inches thickness, or the equivalent, which are to turn with the guns.

The smaller guns of the secondary battery to be four 6-pounder rapid-firing guns, ten 1-pounder rapid-firing guns, and two 37-millimeter revolving cannon.

The 6-pounder guns are carried on the superstructure deck, and protected by shields on the guns.

Four of the 1-pounder guns are carried on the berth deck, being intended primarily for defense against torpedo-boat attacks by night, and are protected by extra thick plating in wake of their ports and by small shields on the guns.

The remainder of the 1-pounder guns are carried on the superstructure deck and protected by small shields.

The revolving cannon are carried in the fighting-top, and are to have a train of 360 degrees each.

The ammunition allowances are as below:

	Rounds.
For each 5-inch rapid-firing gun	120
For each 6-pounder rapid-firing gun	300
For each 1-pounder rapid-firing gun	600
For each 37-millimeter revolving cannon	1200

TORPEDO OUTFIT.

To consist of six tubes above water, two fixed at the bow, and diverging at 5 degrees, and to be worked simultaneously, and four training at the corners of the armored casemate.

There are to be 12 torpedoes carried.

EQUIPMENT AND OUTFIT.

A single military mast is fitted with one top. A derrick to be fitted for handling boats. The supply of boats and life-rafts to be only sufficient for the ordinary service of the ship and for life-saving purposes. The complement, officers and men, is fixed at three hundred.

MOTIVE POWER.

Boilers.—Under forced draught to supply steam of 160 pounds pressure for main engines and auxiliaries. The main boilers to be

four in number. Two of them to be 15 feet in diameter by 18 feet 6 inches long, double-ended, with eight furnaces and a common combustion chamber. Two of them to be 15 feet in diameter by 10 feet long, single-ended, with four furnaces and a common combustion chamber.

The boilers to be arranged in two water-tight compartments, one on either side of the middle line, the double-ended boiler forward and the single-ended boiler aft in each boiler-room.

The aggregate heating surface of main boilers to be about 14,100 square feet, and the corresponding indicated horse-power required of main and auxiliary engines, 7250.

Engines.—The main engines to be two in number, one on each shaft, and of the vertical, triple-expansion, three-cylinder type. The cylinders to be 31, 46¼, and 69¼ inches in diameter, respectively, and the stroke, 39½ inches. The revolutions corresponding to the proposed maximum speed of 15.8 knots to be one hundred and one per minute, when it is expected that the main engines will develop about 6500 indicated horse-power. The piston speed at the proposed maximum revolutions will be 665 feet per minute.

COAL ENDURANCE.

The coal supply at load draught is 230 tons, and the total coal capacity is estimated at 425 tons. On the coal at load draught the steaming distance at 10 knots is 2550 miles. On the total coal capacity the steaming distance at 10 knots is 4600 miles. At full sea speed of 15.2 knots the steaming distance on the total coal capacity is 1100 miles.

ASSIGNMENT OF WEIGHTS.

		Tons.
Hull proper and fittings		1,725
Hull protection:		
Belt	925	
Deck armor and glacis	545	
Casemate armor	158	
Water-excluding material	50	
		1,678
Conning tower and armored shaft		58
Forward great-gun position (turret and guns, redoubt, ammunition, and equipment)		795
After great-gun position (guns, barbette, ammunition, and equipment)		320
Secondary battery, gatlings, and small arms, with ammunition, torpedo outfit, and search lights (108), and protection (50)		158

	Tons.
Propelling machinery, with stores and spare parts	725
Auxiliary machinery, including electric lighting	75
Coal at load displacement	230
Equipment and outfit	235
Total	5,999

ESTIMATED COST.

Hull and armor	$2,488,500
Propelling and auxiliary machinery	549,600
Ordnance and torpedo outfit	488,500
Equipment outfit and stores	81,000
	$3,607,600

CRUISERS.

The numerous duties expected of this general type in war may be stated as:

(*a*). When acting singly or in small cruising squadrons—

(1) To destroy commerce.

(2) To convoy commerce.

(3) To generally protect commerce by clearing the trade routes of the enemy's cruisers.

(4) To ravage the enemy's coasts at unprotected or weakly defended points.

(5) To carry on the smaller naval wars in distant countries, effect reprisals, etc.

(*b*). When acting directly or indirectly with a squadron of battleships—

(6) To act as scouts, keep touch with the enemy, mark and give prompt information of his movements, cut off disabled vessels, harass his weaker ships as opportunity offers, and especially his supply ships.

(7) To keep touch between the squadron and its base of supplies, and protect the route of supplies.

(8) In squadron under way, to form the front, rear, and wings of the fleet, making first contact with an enemy, and engaging them until their force becomes well defined and order of battle may be laid down. To engage the lighter ships, during action, and, as far as their fighting power will permit, act as reserves to strengthen weak places in the line, and generally fulfill certain tactical requirements connected with the line of battle.

(9) In squadron blockading, by their great numbers and activity, to insure the efficiency of the blockade, to serve as bases of supplies for the numerous lighter vessels, such as sea-going torpedo-boats required for this service, to pursue and destroy or capture similar ships of the enemy which may pass the lines.

(10) In squadron blockaded, by their number and activity, to deceive and disconcert the blockading force and mark the opportunities for sally. To escape singly or in small numbers, and, by ravaging the enemy's coast and destroying commerce and attacking the supply routes of his squadron, to effect the diversion of a superior force from the blockade or other sources.

While all vessels of the cruiser type should be more or less well adapted to all these services, the necessary development of special fitness for one or more particular services results in the creation of numerous types, differing widely in size and power.

Certain broad features are believed to obtain universally with this class, viz.:

(1) The use of steam of high pressure in triple expansion, with machinery of types specially adapted to the wide range of speed and fuel economy demanded of all vessels of this class, has rendered it undesirable to assign any of the displacement to sail power. Under present conditions a better return will be given by applying such weight to other qualities, and particularly to the coal endurance. But it becomes all the more desirable for the country to obtain and strongly defend coaling stations at certain points, and especially one in mid-Pacific. The attention of the Department is also directed to the necessity of immediate careful study of fuel consumption in all distinct types of vessels added to the navy, and especially in cruisers, and in addition to the supply and general use of the fuel best adapted to present conditions.

(2) It is believed that a certain line of size is drawn at about 3000 tons displacement for vessels intended to act singly, by the impossibility of combining the necessary speed and endurance in smaller vessels, and of fitting the very necessary feature of a satisfactory double bottom, and by the very serious loss of speed in a moderate sea-way. Smaller vessels of the class should not exceed 1200 tons displacement, with very high smooth-water speed, and armed only

with the lightest wea[illegible] being incapable of efficient single action, their endurance may be [illegible] than the 9000 miles at 10 knots, which it is believed all the larger cruisers should possess. Their place is with the fleet or as part of the torpedo-boat defense.

(3) The minimum smooth-water speed of the larger vessels should not be less than 19 knots, otherwise sufficient mobility will not be possessed for many of the services required. Similarly, an endurance of 9000 miles at 10 knots may be accepted as a minimum for independent action, and should generally be considerably, and in some vessels largely, exceeded.

(4) Inasmuch as it is now possible to prepare a steel bottom against fouling to give perfectly satisfactory results for continuous cruising for a time from three to five times the coal endurance, for a time, indeed, so long that it becomes questionable whether, as dependent on prizes alone for continuance of fuel supply, many vessels, even of the cruiser class, will require to remain longer out of the home ports, it is clear that sheathing such ships with wood and copper must be classed with sail-power as not affording an adequate return of efficiency. Sheathing must then be regarded as a concession to the peace duties of war-ships, though it should be noted that it is by no means a complete remedy for the evil of fouling, sheathed ships lying for several months in harbor, as very commonly happens in time of peace, being found fouled as badly as can be and suffering the same loss of speed and fuel economy as an unprotected iron hull. It so happens that below the limiting minimum displacement of 3000 tons, numerous types of vessels may be built of moderate speed and endurance, more or less complete sail-power, hulls sheathed with wood and coppered against fouling—and thus also rendered better able to take the ground under ordinary circumstances than a steel hull with a double bottom—vessels very well adapted to the economical performance of the peace duties of a navy; but it is now very generally conceded that such constructions are essentially extravagant as having no place or function in time of war with powerful nations.

The Board has hereinbefore declared its opinion that true ultimate economy exists in building for war purposes only, the trifling apparent economy resulting from building vessels essentially adapted to the peace duties of the navy being out of all proportion to the depreciation in value of all such material in time of war, for which the navy essentially exists, while the training of the personnel in the one class of ships is not conducive to the highest efficiency in the other.

In connection with its attitude on the sheathing question, the Board desires to impress on the Department, as a measure of efficiency and economy, the necessity of the highest attainable standard in the matter of protective and anti-fouling compositions and their application to the bottoms of ships. It is believed to be a matter of the greatest importance, demanding the most intelligent special study and accumulated experience, and not to be advanced by detached and disconnected experiments. The progress made of late years in these matters leads to the belief that much more will soon be accomplished, and the Department is urged to take such measures as will assist the development of the subject, and especially insure a high efficiency in all such work done for the navy.

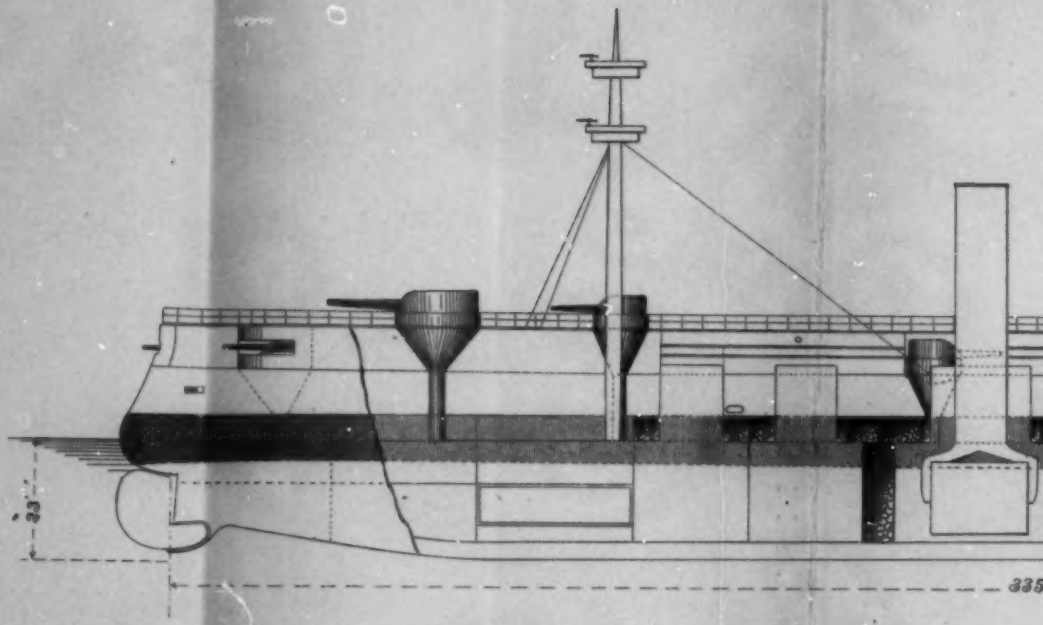
In view of the above-defined propositions, and of the types of cruisers existing in, or about to be added to, the navy, the Board has recommended the construction of no additional cruisers of less than 4000 tons, except certain torpedo-cruisers having the qualities above defined for cruisers of small displacement, and certain gun-vessels for river service. All the cruisers recommended have steel hulls unsheathed, no sail power, a minimum smooth-water speed of 19 knots, and, with the exception of the torpedo-cruisers, a minimum endurance of 10,000 knots at 10 knots, and machinery of a type admitting at once of great power and great economy at low speeds.

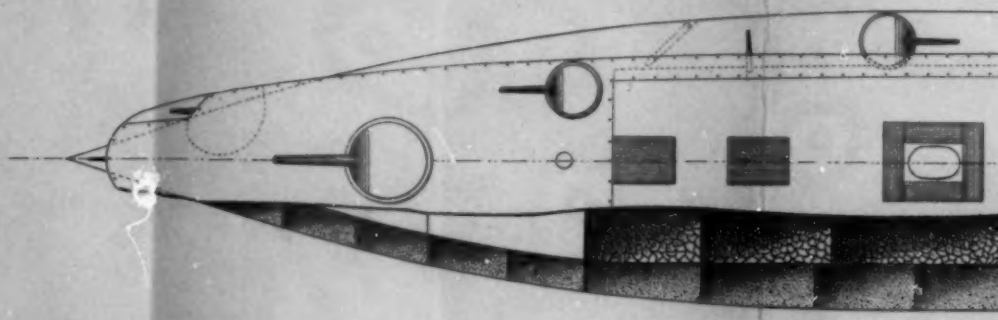
The Board desires to draw special attention to the design of cruiser with thin-armored belt and complete local protection to the guns, as representing the outcome of applying the arguments advanced on the design of battle-ship of great coal endurance to the case of a cruiser. It is believed that in this type lies the germ of much development. Thus the universal use of high-explosive shell may render it necessary to build all large war-vessels, of whatever class, with protection of this kind, only a somewhat greater thickness of belt armor being demanded for battle-ships, as the best shell to carry high explosives from guns of large calibers through such armor becomes developed. And again, such vessels, with perhaps others of somewhat greater size and heavy gun-power, having so much capacity to give and receive punishment, could in squadron (as it were a fleet of light, fast battle-ships) overcome the defenses of many important ports. In other words, for certain purposes their individual value would be specially increased by concentration into squadrons.

They have been designed to fulfill specially requirements *a* 3, *a* 4, and *b* 8.

TYPE F

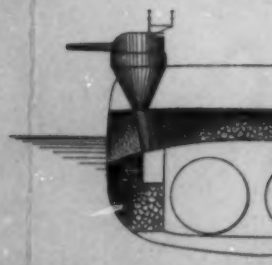
FIRST CLASS THIN AR





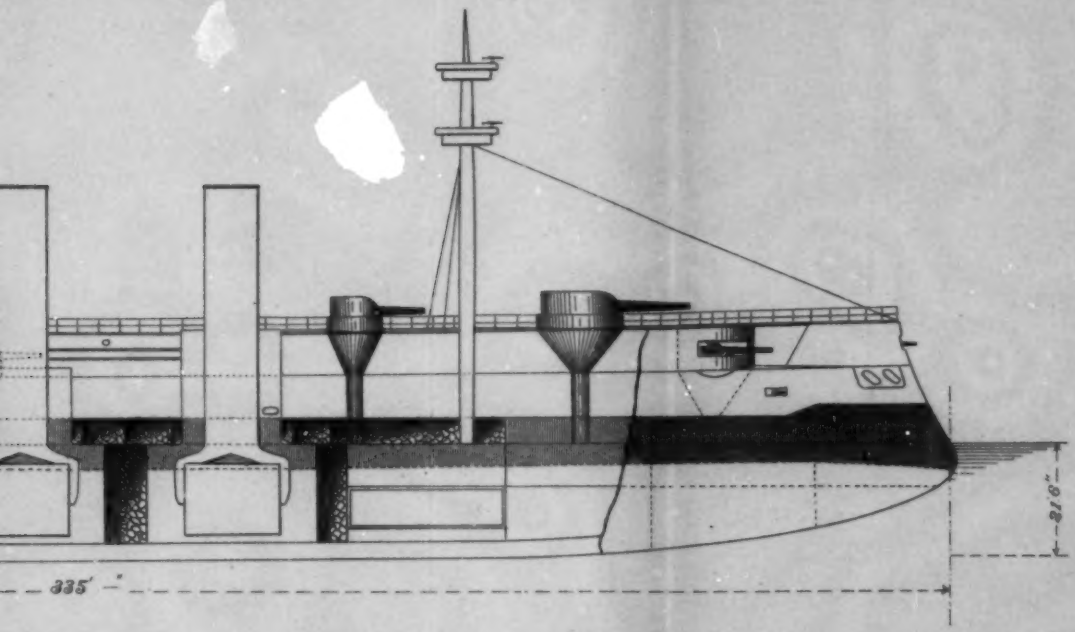
PRINCIPAL DIMENSIONS.

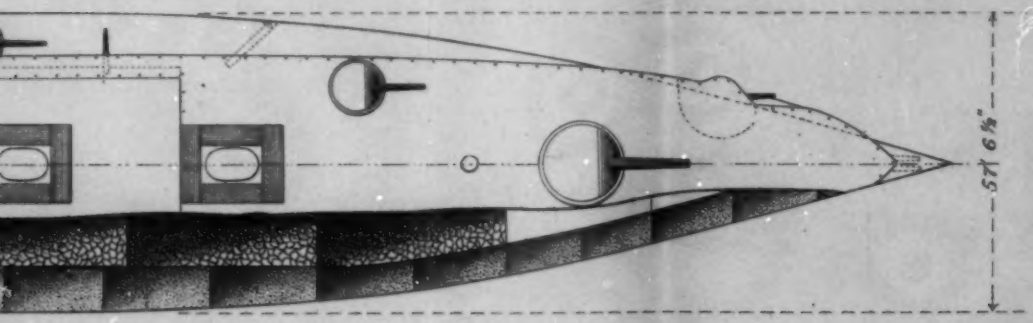
Length between Perpendiculars, 335'—"
Beam Extreme, ... 57'6½"
Mean Draught, ... 22'3"
Load Displacement in Tons, . . . 6250
Maximum I. H. P., ... 9600
Maximun Speed in Knots, ... 19

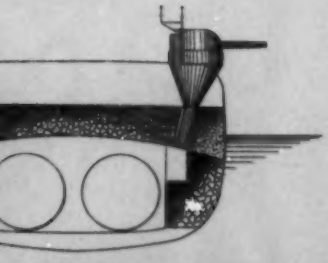


PE PLAN.

IIN ARMORED CRUISER.







ARMAMENT.

2—8 *inch B. L. R.*
10—5 *inch R. F. G.*
6—6 *pounder R. F. G.*
8—1 *pounder R. F. G.*
4—37 *mm. R. C.*
6—*Torpedo Tubes.*

The first-class protected cruiser is specially adapted to the requirements of divisions *a* 1, *a* 3, *a* 4, *b* 6, and certain of the duties of *b* 9 and *b* 10. She has the unexcelled speed of 22 knots and coal endurance of 15,000 miles. Her gun-power is good, equal to that of the largest protected cruisers built or building by other nations, and her protection by armor deck and stability belt is such as to enable her to stand considerable punishment.

To obtain these qualities it has been necessary to adopt the somewhat large displacement of 7500 tons, which incidentally assures the maintenance of very high speed at sea in all weathers, and makes her capable of overtaking any merchant steamer now completed or likely to be built in the near future, while able to match or overpower any man-of-war approaching her in speed.

Two types of second-class protected cruisers are recommended. The first, of 5400 tons, may be considered the standard type of protected cruiser, being equally well adapted to each of the duties required of this class, except that from her size and cost such vessels may not be sufficiently numerous. Her gun-power and defensive qualities both exceed those of the first-class cruiser.

The smaller type, of about 4000 tons, fairly represented by such vessels as the Baltimore, with the addition of somewhat greater capacity to receive water-line injury, and a reduction of great-gun power, is less well adapted to independent action, but almost equally useful with a fleet, while their reduced cost assists their numbers.

For services in the cruiser class, involving only small powers of offense and defense, with good sea speed and endurance, unless the cost of the cruiser fleet is to be much increased, reliance must be had on the development of an auxiliary navy of merchant steamers. To this end it will be necessary to offer suitable inducements for owners of vessels in certain trades to build them up to a certain limit of speed and under certain requirements as to subdivision and local strength for light-gun positions. The advantage, both to the Government and to owners in trades requiring vessels of fair speed, is so obvious that the Board considers no elaborate arguments necessary to demonstrate the wisdom of such an arrangement, the conclusion of which is contemplated in the fleet proposed.

THIN-ARMORED CRUISERS OF 6250 TONS.

Principal Dimensions, etc.

Length over all	345′	0″
Length on load water-line	344′	0″
Length between perpendiculars	335′	0″
Beam extreme	57′	6½″
Mean draught	22′	3″
Displacement in tons	6250	
Free-board to top of berth-deck plank at side	5′	0″
Free-board to top of main-deck plank at side	13′	0″
Maximum indicated horse-power (forced draught)	9600	
Maximum speed in knots	19	
Estimated metacentric height	4′	0″

HULL AND ITS PROTECTION.

To have a double bottom running well fore and aft and to the turn of the bilge on either side. The engines to be in four compartments, and the boilers in two, with thwartship coal bunkers. Wing coal bunkers to be fitted in addition, and the subdivision forward and aft to be as close as the requirements of stowage, etc., will permit. To have a long poop and forecastle.

The buoyancy and stability are to be protected—

(1) By a complete belt of armor extending from the under side of berth-deck plank to 4 feet 6 inches below the water amidships, rising to 3 feet 6 inches below the water forward and aft and thence down to the ends of the ship. This belt to be 5 inches thick for one-third the length amidships, and 4 inches thick forward and aft. This armor to be worked on frames without backing.

(2) By an arched armored deck reaching the water-line at its crown amidships and the bottom of the armor belt at sides. To be 2½ inches thick at the center and 2½ inches thick at the sides.

(3) By a complete belt of water-excluding material between the armor and berth decks. This is worked outside of sloping water-tight wing bulkheads between the armor deck and the berth deck as shown. The belt to be about 9 feet thick at the water-line amidships, and to taper gradually with the curve of the water-line until its thickness is 6 feet, this thickness being retained for the rest of the length. The belt to be divided at suitable intervals by partial transverse bulkheads, as shown.

(4) Within the wing bulkheads of the belt, coal to be stowed over the armor deck as shown, and light water-excluding stores forward and aft. The coal bunkers above the armor deck to have transverse bulkheads only.

Glacis to be worked around openings in the armor deck for smoke-stack, etc., and armor gratings and coffer-dams as required.

CONNING TOWER.

A conning tower, with sides of not less than 6 inches, to be fitted on the bridge or in other suitable commanding position.

ARMAMENT AND ITS PROTECTION.

The battery to consist of two 8-inch breech-loading rifles, ten 5-inch rapid-firing guns, six 6-pounder rapid-firing guns, eight 1-pounder rapid-firing guns, and four 37-millimeter revolving cannon.

The 8-inch guns are mounted in the middle line, one on the poop and one on the forecastle, in partial barbettes 3½ inches thick. A shield covers the rear of the gun and the crew. This shield is 3½ inches thick in front and its equivalent elsewhere. Beneath these barbettes are worked protective cones with tubular bases each 2 inches thick. The tubes lead below the armor deck, and ammunition is to be supplied through them. Four of the 5-inch guns are mounted on poop and forecastle, and two in the waist, similarly to the 8-inch guns, but with barbette and shield 3 inches thick or the equivalent.

The cone and tube are 2 inches thick or the equivalent.

The remaining four 5-inch guns are mounted on the main deck forward and aft, in recessed ports with thick plating and closed shields, in rear equivalent to 3 inches, and with cone and tube beneath the position as at the other mounts. The smaller guns are mounted as shown on the plans, being protected by small shields on the guns or by extra thick plating in wake of ports.

The ammunition allowances are as below:

	Rounds.
For each 8-inch breech-loading rifle	80
For each 5-inch rapid-firing gun	160
For each 6-pounder rapid-firing gun	500
For each 1-pounder rapid-firing gun	750
For each 37-millimeter revolving cannon	2000

EQUIPMENT AND OUTFIT.

Two military masts, to be fitted with fighting-tops. Derricks to be fitted for handling boats, including two 60-foot torpedo vidette boats. The complement of officers and men is fixed at four hundred.

MOTIVE POWER.

Boilers.—Under forced draught to supply steam of 160 pounds pressure for main engines and auxiliaries. The main boilers to be

four in number, 14 feet 7 inches in diameter by 18 feet 6 inches long, double-ended, with six furnaces and a common combustion chamber.

The boilers to be arranged in two water-tight compartments separated by a transverse coal bunker. Aggregate heating surface of main boilers to be about 17,300 square feet, and corresponding indicated horse-power, 9600.

Engines.—The main engines to be four in number, two on each shaft, and of the vertical, triple-expansion, three-cylinder type.

The cylinders to be 26, 38, and 58½ inches in diameter respectively, and the stroke, 33 inches. The revolutions corresponding to the proposed maximum speed of 19 knots to be one hundred and thirty-three per minute, when it is expected that the main engines will develop about 9600 indicated horse-power. The piston speed at the proposed maximum revolutions will be 732 feet per minute.

Donkey.—A donkey boiler to be carried on the armor deck. To have about 20 square feet of grate surface, and about 620 square feet of heating surface.

Coal endurance.—The coal supply at load draught is 625 tons, and the total coal capacity is estimated at 950 tons. On the coal at load draught the steaming distance at 10 knots is 7000 miles. On the total coal capacity the steaming distance at 10 knots is 10,700 miles. At full sea speed of 17.9 knots the steaming distance on the total coal capacity is 2100 miles.

ASSIGNMENT OF WEIGHTS.

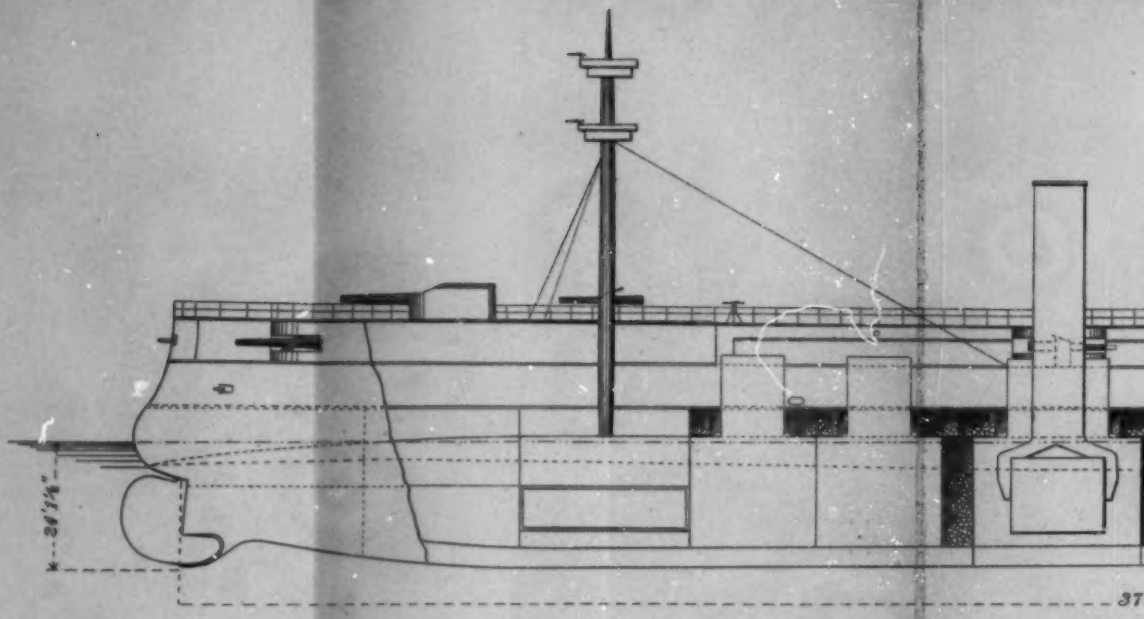
	Tons.	Tons.
Hull proper and fittings, including 6-inch conning tower (15 tons) and extra plating on berth deck		2,400
Hull protection:		
Armor	460	
Armor deck	600	
Water-excluding material	200	
		1,260
Armament (326) and its protection (312)		638
Machinery, donkey, stores, and spare parts		913
Coal at load displacement		625
Equipment and outfit		415
Total		6,251

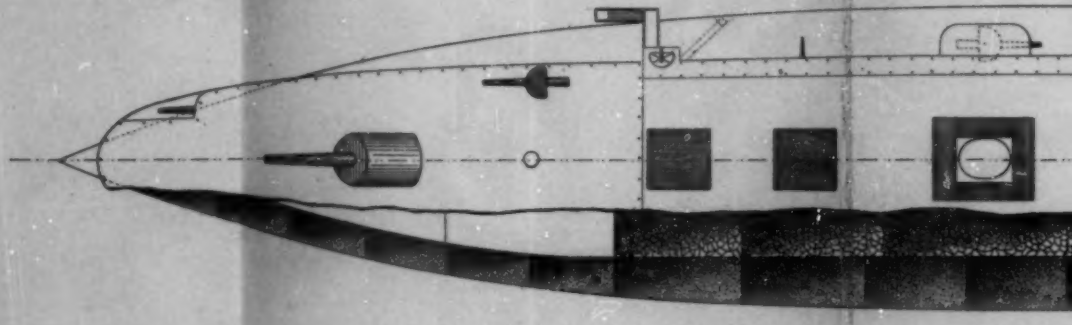
ESTIMATED COST.

Hull and protection	$2,085,300
Machinery	623,000
Ordnance	371,800
Equipment	120,000
	$3,200,100

TYPE

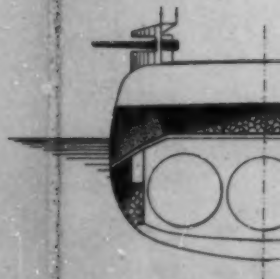
FIRST CLASS PROT





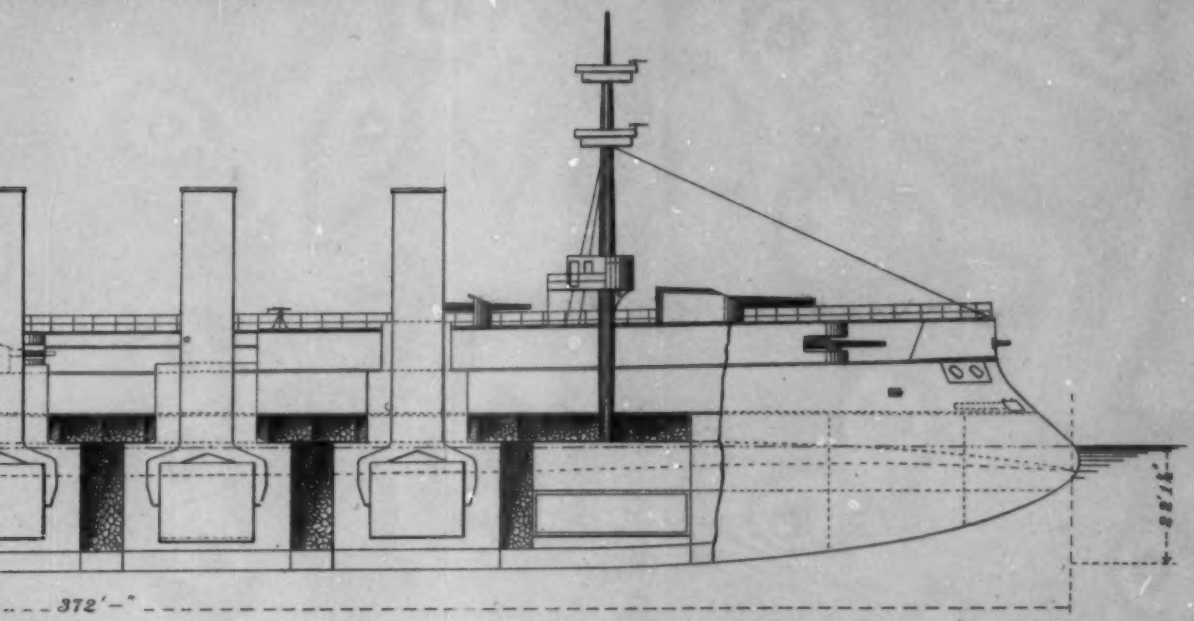
PRINCIPAL DIMENSIONS.

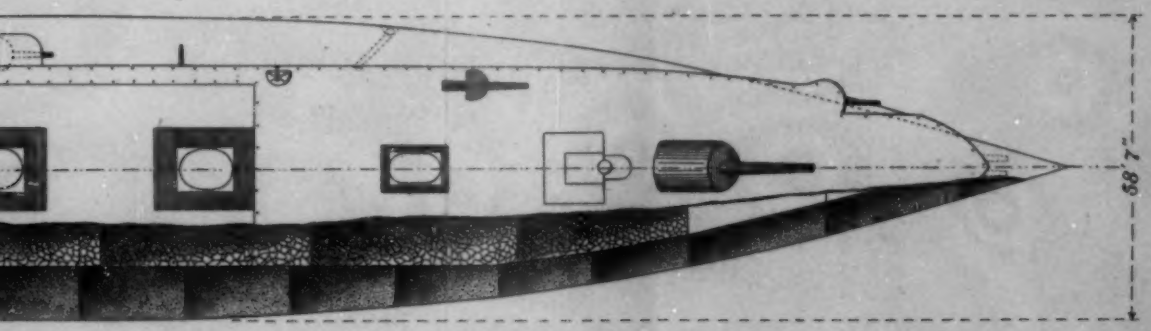
Length between Perpendiculars, 372'—"
Beam Extreme, ... 58' 7"
Mean Draught, ... 23' 1⅛"
Load Displacement in Tons, . . . 7500
Maximum I. H. P., ... 20,250
Maximum Speed in Knots, ... 22

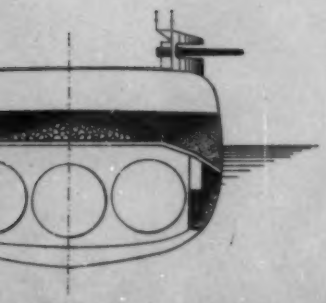


PE PLAN.

PROTECTED CRUISER.







ARMAMENT.

2—8 *inch B. L. R.*
10—5 *inch R. F. G.*
6—6 *pounder R. F. G.*
8—1 *pounder R. F. G.*
4—37 *mm. R. C.*
6—*Torpedo Tubes.*

EDEWALD PHOTO-LITH. BALTO.

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FIRST-CLASS PROTECTED CRUISER OF ABOUT 7500 TONS.

Principal Dimensions, etc.

Length over all	382′	6″
Length on load water-line	381′	0″
Length between perpendiculars	372′	0″
Beam extreme	58′	7″
Mean draught	23′	1½″
Displacement in tons	7500	
Free-board to top of berth-deck plank at side	5′	9″
Free-board to top of main-deck plank at side	13′	9″
Maximum indicated horse-power (forced draught)	20,250	
Maximum speed in knots	22	
Estimated metacentric height	4′	5″

HULL AND ITS PROTECTION.

To have a double bottom running well fore and aft and to the turn of the bilge on either side. The engines to be in four compartments and the boilers in three, with thwartship coal bunkers. Wing coal bunkers to be fitted in addition, and the subdivision forward and aft to be as close as the requirements of stowage, etc., will permit. To have a long forecastle and ordinary poop.

The buoyancy and stability to be protected—

(1) By an armor deck with flat crown 1 foot above the water and 2 inches thick. This is to slope to the side with two slopes, the inner of 20 degrees and the outer of 32 degrees. Plating on both slopes to be 4 inches in thickness. The edge of the armor deck to be 5 feet below the water amidships.

(2) By a belt of water-excluding material worked outside of sloping water-tight wing bulkheads between the armor deck and the berth deck as shown. The belt to be 10 feet thick at the water-line amidships, tapering with the water-line, as shown, to a thickness of 6 feet, which is continued forward and aft, and divided at suitable intervals by partial transverse bulkheads.

(3) Within the wing bulkheads of belt, coal to be stowed, as shown, above the armor deck in wake of the machinery space and light and water, excluding stores forward and aft of the coal as far as practicable. The coal bunkers above the armor deck to be subdivided by transverse bulkheads only.

Glacis to be worked around openings in the armor deck for smoke-stacks, etc., and armor-gratings and coffer-dams as required.

CONNING TOWER.

A conning tower, with sides of not less than 6 inches thickness, to be fitted on the bridge or in other suitable commanding position.

ARMAMENT AND ITS PROTECTION.

The battery to consist of two 8-inch breech-loading rifles, ten 5-inch rapid-firing guns, six 6-pounder rapid-firing guns, eight 1-pounder rapid-firing guns, and four 37-millimeter revolving cannon.

The 8-inch guns to be mounted in the middle line, one on the poop and one on the forecastle, as shown. They are to be completely shielded by closed shields, as shown, which are to work with the guns. These shields are to have a front of 2 inches, sides of 1½ inches, and rear of 1 inch. The sloping part of the crown in front to be 1½ inches thick, and the remainder of the crown, ¾ inch. These shields are to be large enough to contain the whole gun's crew. Allowance of weight is made for working these guns by power.

The 5-inch guns are to be mounted as shown, two in the waist, two on the forecastle, two on the poop, two on the main deck under forecastle, and two on the main deck under poop.

The guns on poop and forecastle to be protected by shields on the guns of 2 inches in front and the equivalent elsewhere. The remainder of the 5-inch guns are protected by plating around their ports, 2 inches in thickness, with equivalent small shields on the guns to cover the ports. The smaller guns to be mounted as shown on the plans, the 6-pounders being protected by shields on the guns.

The ammunition allowances are as below:

	Rounds.
For each 8-inch breech-loading rifle	70
For each 5-inch rapid-firing gun	130
For each 6-pounder rapid-firing gun	500
For each 1-pounder rapid-firing gun	750
For each 37-millimeter revolving cannon	2000

TORPEDO OUTFIT.

To have six torpedo-tubes. Two in the bow are fixed, diverging with the angle between them 5 degrees, and arranged to work simultaneously. The remaining four are training tubes, two on each broadside, one forward and one aft. Fifteen torpedoes to be carried.

EQUIPMENT AND OUTFIT.

Two military masts, to be fitted with fighting-tops. Derricks to

be fitted for handling boats, including two 60-foot vidette boats. The complement of officers and men is fixed at four hundred and thirty.

MOTIVE POWER.

Boilers.—Under forced draught to supply steam of 160 pounds pressure for main engines and auxiliaries. The main boilers to be eight in number, 15 feet in diameter by 18 feet 6 inches long, double-ended, with six furnaces and a common combustion chamber. The boilers to be arranged in three water-tight compartments, separated by transverse coal bunkers. Aggregate heating surface of main boilers to be about 36,500 square feet, and corresponding indicated horse-power, 20,250.

Engines.—The main engines to be four in number, two on each shaft, and of the vertical, triple-expansion, three-cylinder type. The cylinders to be 33½, 50½, and 75¾ inches in diameter respectively, and the stroke, 40 inches. The revolutions corresponding to the proposed maximum speed of 22 knots to be one hundred and thirty-six per minute, when it is expected that the main engines will develop about 20,250 indicated horse-power. The piston speed at the proposed maximum revolutions will be 907 feet per minute.

Donkey.—A donkey boiler to be carried on the armor deck. To have about 22 square feet of grate surface, and about 690 square feet of heating surface.

COAL ENDURANCE.

The coal supply at load draught is 900 tons, and the total coal capacity is estimated at 1600 tons. On the coal at load draught the steaming distance at 10 knots is 8600 miles. On the total coal capacity the steaming distance at 10 knots is 15,000 miles. At full sea speed of 20.8 knots the steaming distance on the total coal capacity is 2100 miles.

ASSIGNMENT OF WEIGHTS.

	Tons.
Hull and fittings (including conning tower)	2,800
Protection:	
Armor deck 880	
Water-excluding material 190	
	1,070
Propelling machinery, donkey, stores, and spare parts	1,815
Coal at load displacement	900
Armament, its protection and ammunition	362
Equipment, outfit and stores	550
Total	7,497

ESTIMATED COST.

Hull and protection	$2,084,000
Machinery	1,260,000
Armament and ammunition	400,000
Equipment and outfit	197,500
Total	$3,941,500

SECOND-CLASS PROTECTED CRUISERS OF 5400 TONS.

Principal Dimensions, etc.

Length over all	337′ 6″
Length on load water-line	335′ 6″
Length between perpendiculars	324′ 0″
Beam extreme	53′ 6″
Mean draught	20′ 7″
Displacement in tons	5400
Free-board to top of berth-deck plank at side	5′ 6″
Free-board to top of main-deck plank at side	13′ 6″
Maximum indicated horse-power (forced draught)	12,000
Maximum speed in knots	20
Estimated metacentric height	4′ 25″

HULL AND PROTECTION.

To have a double bottom running well fore and aft and to the turn of the bilge on either side. The engines to be in four compartments and the boilers in two, with athwartship coal bunkers. Wing coal bunkers to be fitted in addition, and the subdivision forward and aft to be as close as the requirements of stowage, etc., will permit. To have a long forecastle and ordinary poop (a preferable arrangement for this ship may be with central superstructure and free-board forward and aft to main deck only).

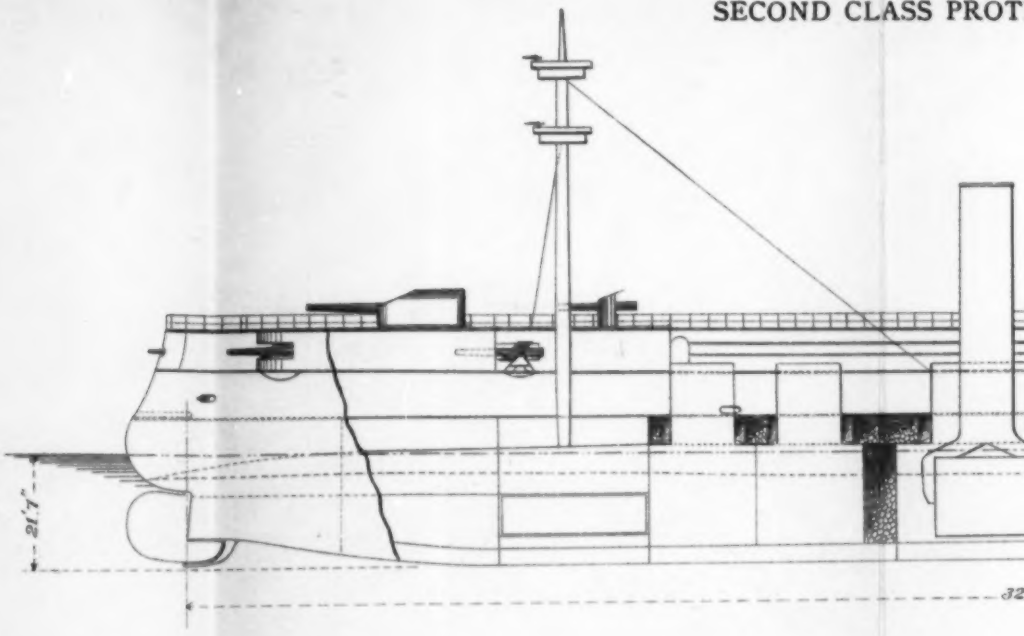
The buoyancy and stability to be protected:

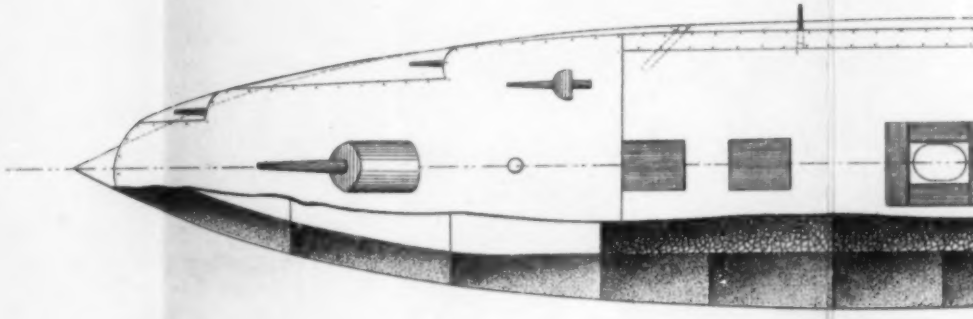
(1) By an armor deck with flat crown 1 foot above the water-line and 2½ inches thick. This to slope to the side with two slopes, the inner of 22 degrees and the outer of 36 degrees. Plating on both slopes is to be 4½ inches thick. The edge of the armor deck to be 4 feet 6 inches below the water amidships.

(2) By a belt of water-excluding material worked outside sloping water-tight wing bulkheads between the armor deck and the berth deck, as shown. The belt to be 10 feet thick at the water-line amidships, tapering with the water-line, as shown, to a thickness of 5½ feet, which is continued forward and aft, and divided at suitable intervals by partial transverse bulkheads.

TYPE P

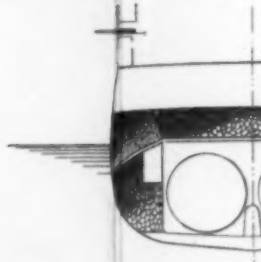
SECOND CLASS PROT





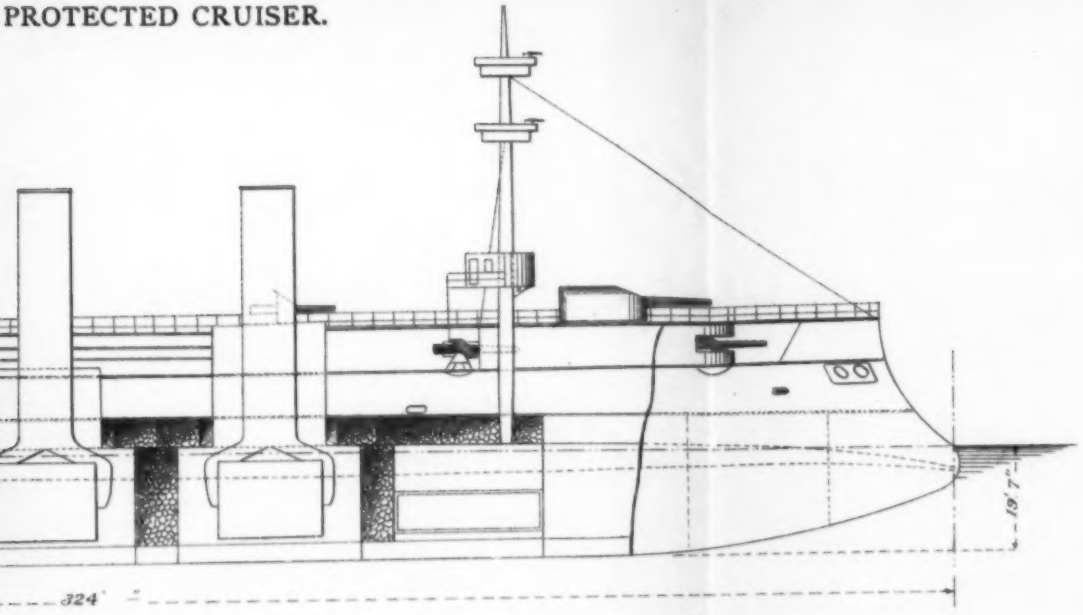
PRINCIPAL DIMENSIONS.

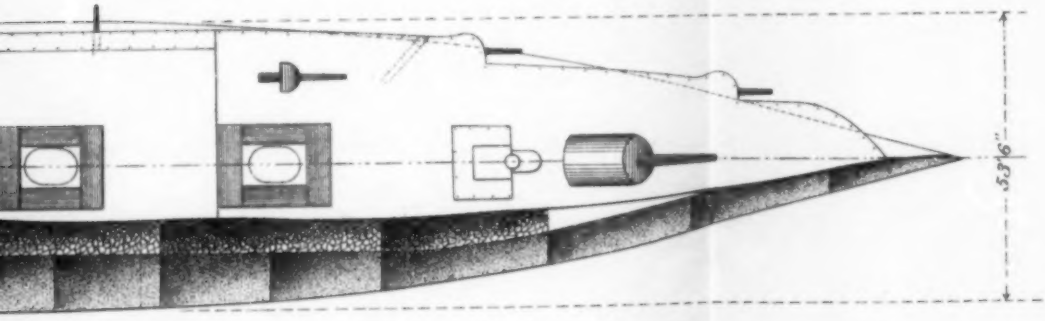
Length between Perpendiculars, 324'—"
Beam Extreme, ... 53' 6"
Mean Draught, ... 20' 7"
Load Displacement in Tons, ... 5400
Maximum I. H. P., ... 12,000
Maximum Speed in Knots, . . . 20

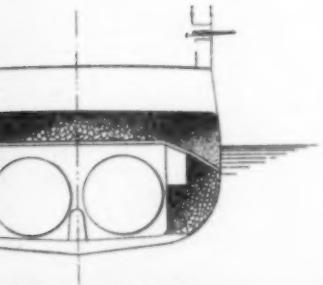


PE PLAN.

PROTECTED CRUISER.







C. FRIEDENWALD, PHOTO LITH. BALTO.

ARMAMENT.

2—8 *inch B. L. R.*
12—5 *inch R. F. G.*
6—6 *pounder R. F. G.*
4—1 *pounder R. F. G.*
4—37 *mm. R. C.*
6—*Torpedo Tubes.*

(3) Within these wing bulkheads coal to be stowed above the armor deck, as shown, in wake of the machinery space, and light water-excluding stores forward and aft. The coal bunkers above the armor deck to be subdivided by transverse bulkheads only.

Glacis to be worked around openings in the armor deck for smokestacks, etc., and armor-gratings and coffer-dams as required.

CONNING TOWER.

A conning tower with sides of not less than 6 inches in thickness to be fitted on the bridge or in other suitable commanding position.

ARMAMENT AND ITS PROTECTION.

The battery to consist of two 8-inch breech-loading rifles, twelve 5-inch rapid-firing guns, six 6-pounder rapid-firing guns, four 1-pounder rapid-firing guns, four 37-millimeter revolving cannon.

The 8-inch guns are to be mounted in the middle line, one on the poop and one on the forecastle, as shown. They are to be completely shielded by close shields, as shown, which are to work with the guns. These shields are to have a front of 2 inches, sides of 1½ inches, and rear of 1 inch, the sloping part of the crown in front to be 1½ inches thick, and the remainder of the crown, three-quarter inch. These shields are to be large enough to contain the whole gun's crew. Allowance of weight is made for working these guns by power.

The 5-inch guns are to be mounted as shown, two on the poop, two on the forecastle, and the remaining eight in recessed ports on the main deck, four forward and four aft, the guns on poop and forecastle to be protected by shields on the guns of 2 inches in front and the equivalent elsewhere, the 5-inch guns on the main deck to be protected by 2-inch plating around their ports, with equivalent small shields on the guns to cover the ports.

The smaller guns are to be mounted as shown on the plans, the 6-pounders being protected by shields on the guns. The ammunition allowances are as below:

	Rounds.
For each 8-inch breech-loading rifle	70
For each 5-inch rapid-firing gun	125
For each 6-pounder rapid-firing gun	500
For each 1-pounder rapid-firing gun	750
For each 37-millimeter revolving cannon	2000

TORPEDO OUTFIT.

To have six torpedo-tubes. Two in the bow are fixed, diverging with the angle between them 5 degrees, and arranged to work simultaneously. The remaining four are training tubes, two on each broadside, one forward and one aft. Fifteen torpedoes to be carried.

EQUIPMENT AND OUTFIT.

Two military masts, to be fitted with fighting-tops. Derricks to be fitted for handling boats, including two 60-foot vidette torpedo-boats. The complement, officers and men, to be fixed at four hundred.

MOTIVE POWER.

Boilers.—Under forced draught to supply steam of 160 pounds pressure for main engines and auxiliaries. The main boilers to be four in number, 15 feet 2 inches in diameter by 20 feet long, double-ended, with eight furnaces and two combustion chambers. The boilers to be arranged in two water-tight compartments, separated by transverse coal bunkers. Aggregate heating surface of main boilers to be about 21,500 square feet, and corresponding indicated horse-power, 12,000.

Engines.—The main engines to be four in number, two on each shaft, and of the vertical, triple-expansion, three-cylinder type. The cylinders to be 27½, 41, and 61½ inches in diameter respectively, and the stroke, 35½ inches. The revolutions corresponding to the proposed maximum speed of 20 knots to be one hundred and forty per minute, when it is expected that the main engines will develop about 12,000 indicated horse-power. The piston speed at the proposed maximum revolutions will be eight hundred and twenty-eight feet per minute.

Donkey boiler.—A donkey boiler to be carried on the protective deck. To have about 20 square feet of grate surface, and about 620 square feet of heating surface.

COAL ENDURANCE.

The coal supply at load draught is 540 tons, and the total coal capacity is estimated at 900 tons. On the coal at load draught the steaming distance at 10 knots is 6700 miles. On the total coal capacity the steaming distance at 10 knots is 11,200 miles. At full sea speed of 19 knots the steaming distance on total coal capacity is 1850 miles.

ASSIGNMENT OF WEIGHTS.

	Tons.
Hull and fittings (including conning tower)	2,115
Protection:	
Armor deck 800	
Water-excluding material 140	
	940
Propelling machinery, donkey, stores, and spare parts	1,049
Coal at load displacement	540
Armament, its protection and ammunition	384
Equipment, outfit and stores	380
Total	5,408

ESTIMATED COST.

Hull and protection	$1,542,500
Machinery	715,620
Armament and ammunition	418,000
Equipment and outfit	124,740
Total	$2,800,860

SECOND-CLASS PROTECTED CRUISERS OF ABOUT 4000 TONS

No plans are submitted of this type, of which several examples have been and are about to be added to the navy.

Future vessels of this class, however, should have the special feature of the stability belt, as in the larger types. Their speed should not be less than 19 knots in smooth water, nor their coal endurance less than 9000 miles at 10 knots, as before laid down for the whole class of large cruisers. Their battery should consist of two 8-inch guns at the ends of a long central superstructure, the freeboard forward and aft being to the main deck only. In and on the superstructure at least eight 5-inch and other smaller rapid-fire guns should be mounted. All the guns should be protected as in the other types of protected cruisers.

TORPEDO CRUISERS OF FROM 700 TO 1000 TONS.

This type is the chief representative of the class of small cruisers, and should be developed along with the sea-going torpedo-boat. Numerous representatives of this class have been recently added to foreign navies, such as the Sharpshooter class in the British and the Tripoli class in the Italian navies, while in all European navies there are representatives of smaller types in which the same objects are sought for, but we believe by no means so efficiently obtained.

No type plans are presented of this class, but the following general requirements may be laid down:

The displacements should not be less than 700 nor more than 1000 tons, approaching the higher limit, with lengths of from 230 to 260 feet. The least smooth-water speed which can be considered satisfactory is 22 knots, with a total endurance of about 3000 miles at 10 knots, the coal carried at normal load displacement to be not less than 60 per cent of the total capacity. The gun armament should consist of two 4-inch and at least six 3-pounder rapid-fire guns, the latter being considered large enough for sure execution against sea-going torpedo-boats. The torpedo armament should consist of two bow tubes fixed at an angle of 5 degrees, working simultaneously, and moderately protected by extra plating; and two training tubes elsewhere. It is suggested and believed to be feasible that the torpedo-tubes should be mounted in pairs on the disappearing principle, to be exposed only immediately before and after firing. Every means of incidental protection to the hull, by coal and otherwise, should be utilized, and direct protection afforded in wake of the machinery, so far as the displacement will admit. The subdivision should be very close, and great "emergency" pumping power should be supplied by ejectors in each compartment.

SPECIAL LIGHT-DRAUGHT GUN-VESSELS OF ABOUT 1200 TONS.

These vessels are intended for river service, and are, of necessity, of special type, though it has not been considered necessary to present plans. Their normal load draught should not exceed 9 feet, with a length of about 230 feet. Maximum speed not less than 18 knots, and coal endurance of about 3000 knots at 10 knots. Gun battery should consist of two 4-inch and four 1-pounder rapid-fire guns, four 37-millimeter revolvers, and four 45-caliber machine guns. They should have a high free-board with complete berth deck, and raised quarterdeck and sunk forecastle, affording accommodation on occasions for a very large complement. They should be driven by twin screws with horizontal engines and locomotive boilers, the machinery being under an arched water-tight deck, extending to about 12 inches below water at sides. Subdivision below water should be close, and great emergency pumping power should be supplied by ejectors in each compartment.

TORPEDO-DEPOT AND ARTIFICER'S SHIPS.

The necessity of economizing space and weight on modern war-ships prevents the installation on board each ship of many of the

tools and appliances frequently needed for the repairs of machinery, boilers, etc. When, however, a large number of such ships, constituting a squadron, are employed together, the necessity of supplying adequate means of repair becomes so great that it is advisable to have each such squadron accompanied by a vessel of special design, fitted out with all the appliances requisite for the ordinary repairs of large machinery, and having as a part of her complement a large force of skilled mechanics and artificers. Such vessels are of special importance to the United States, which possesses no foreign dockyards or fortified stations where repairs can be executed, and whose cruising squadrons, in time of war, must be self-supporting in every way.

To supply the deficiency of torpedo-boat service with the offensive is another and hardly less important function of this type of vessel, which carries on deck a number of boats, with facilities for rapidly and easily handling them, and whose workshop appliances are equal to the care of the large amount of mechanism of the boats and their torpedoes and appliances.

Experience has shown that besides their peculiar field of offensive action, torpedo-boats, by their great mobility, are invaluable in blockading or investing a port or harbor. In spite of great increase of size, the "sea-going torpedo-boat" cannot accompany a squadron on any distant operations, while further increase of size would take away from the torpedo-boat many of its essential features. Required to make its own course, therefore, the torpedo-boat is confined to coast and harbor defense or to offensive operations in waters adjacent to its ports, and great advantage in this respect commonly lies with the defense. Battle-ships generally carry two vidette torpedo-boats, but may not conveniently carry more, and these are very necessary for the immediate service of the costly ironclad. In addition, the vessel carries stores of mines, gun-cotton, etc., suited to mining and countermining operations.

With these qualities it is found possible to combine high speed and great endurance, moderate protection, and a light battery of rapid-fire guns, without demanding a very large displacement. The only fair representative of this class in existence is the Vulcan, building for the British Navy. In the vessels recommended it has not been considered advisable to supply so much deck protection as in the British vessel, while retaining all the essential qualities and equal speed and endurance on a somewhat less displacement.

There can be no question of the very great value of such a vessel for the duties described, but for lack of the fleet for which she essentially exists, such constructions, of course, must be postponed for some years.

TORPEDO-DEPOT SHIP OF 5000 TONS.

Principal Dimensions, etc.

	Feet.
Length over all	358
Length on load water-line	357
Length between perpendiculars	346
Beam extreme	52
Mean draught	18⅜
Displacement in tons	5000
Free-board to top of berth-deck plank at side	4
Free-board to top of main-deck plank at side	13
Free-board to top of spar-deck plank at side	22
Maximum indicated horse-power (forced draught)	10,750
Maximum speed in knots	20
Estimated metacentric height	3$\frac{5}{12}$

HULL AND ITS PROTECTION.

To have a double bottom of moderate extent. The engines to be in four compartments and the boilers in three. The ship to be as thoroughly subdivided as the peculiar nature of its service will permit. The machinery, tools, etc., to be carried on both berth and main decks amidships, which should each be 8 feet in the clear for that purpose. It will probably be necessary to place some fittings in wells of the depth of both decks. To have a complete spar-deck. Buoyancy to be protected by—

(1) A curved water-tight deck, 1 inch thick, which is to be (amidships) 5 feet below the water at sides, and 6 inches below the water in the middle line.

(2) A stability belt of water-excluding material worked as in the cruisers.

(3) Coal stowage above the water-tight deck, as in the cruisers.

ARMAMENT.

The armament to be light, consisting of light guns with shield protection only. Number and size of guns to be determined, but total weight of armament, its protection, and ammunition, not to exceed 80 tons.

EQUIPMENT, ETC.

To carry three military masts, with two derricks on each for handling boats. The complement to be as may be determined, but should be unusually large.

MOTIVE POWER.

Boilers.—Under forced draught to supply steam of 160 pounds pressure for main engines and auxiliaries. The main boilers to be nine in number, all of the long low type. Six of them to be 11 feet in diameter by 19 feet long, and three of them to be 10 feet in diameter by 18½ feet long. Aggregate heating surface of main boilers to be 19,000 square feet, and corresponding indicated horse-power, 10,750.

Engines.—To have four sets of vertical, three-cylinder, triple-expansion engines, working two screws. Cylinders to be 27, 40½, and 61 inches in diameter respectively, and the stroke, 31 inches. The revolutions corresponding to the proposed maximum speed of 20 knots to be one hundred and forty-five per minute, when it is expected that the main engines will develop about 10,750 indicated horse-power. The piston speed at the proposed maximum of revolutions will be 750 feet per minute.

COAL ENDURANCE.

The coal supply at load draught to be about 600 tons, and the total coal capacity, at least 900 tons, and as much greater as practicable. On the coal at load draught the steaming distance at 10 knots is 7500 miles. On the total coal capacity the steaming distance at 10 knots is 11,200 miles. At full sea-speed of 18.9 knots the steaming distance on the total coal capacity is 2000 miles.

TORPEDO-BOATS.

Fourteen torpedo-boats to be carried, each of a length of not less than 60 feet. Particular attention to be paid to their stowage and efficient handling.

PRELIMINARY ASSIGNMENT OF WEIGHTS.

Owing to the novel type of this ship it is impossible to make more than an approximate assignment of weights.

	Tons.
Hull and fittings	2,035
Protection (water-tight deck, 230; water-excluding material, 150)	380
Propelling machinery, etc.	1,010
Ordnance	80
Equipment	450
Normal coal-supply	600
Fourteen 12½-ton torpedo-boats	175
Machinery, tools, and stores for work on board	150
Available for torpedo gear, mines, etc.	120
Total	5,000

RAM.

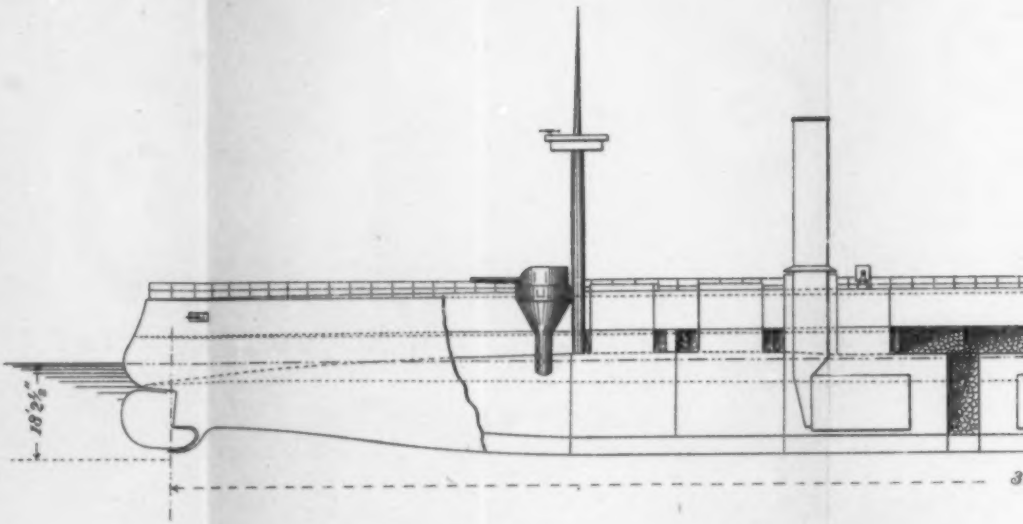
No blow which can be inflicted by any weapon other than a mine or torpedo carrying very large quantities of high explosive can compare in effect to that of a vessel herself moving at a high rate of speed. This has long been recognized, and practically all vessels of war have their bows more or less specially strengthened and shaped for the purpose of ramming. The little experience developed as to the use of the ram leads to the belief that while attempting the operation the other offensive functions of the vessel are best temporarily suspended, and that in ordinary battle-ships and cruisers the presence of other weapons involves qualities not favorable to certainty and efficiency in ramming.

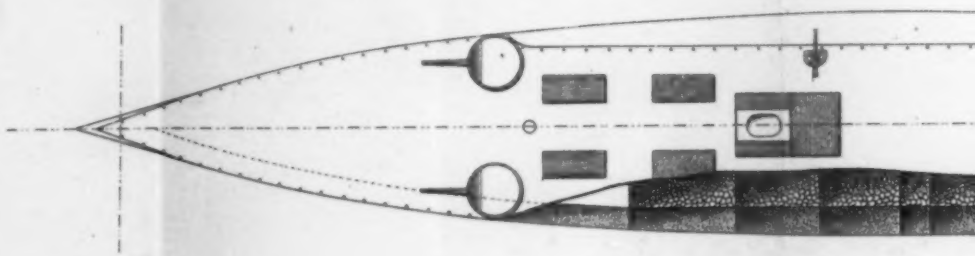
Many propositions have been made looking to the differentiation of the ram from the other ordinary weapons, especially the gun, in the construction of vessels in which all other weapons are, at least, subordinated to the spur. But little has been actually accomplished in this direction, partly from the inherent difficulties and partly because it has been considered doubtful economy to add such vessels to any but a great fleet.

The inherent difficulty lies chiefly in the fact that a number of very antagonistic qualities must be combined in a high degree of efficiency, and especially those of speed, handiness, and capacity to take punishment from the gun. It will be evident that the limits of displacement are very narrow which will admit of a satisfactory combination of those qualities, and it is questionable if any such vessel can be at all satisfactory against more than a single antagonist in daylight. In other words, if out of her proper sphere, or if overmatched at all by more than a single ship, the pure ram loses efficiency very rapidly. For this reason alone a certain amount of gun power is imperative; and, in the shape of rapid-fire guns compara-

TYPE PL

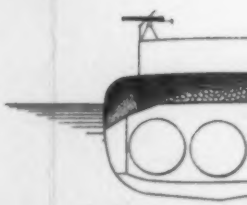
RAM OF LIMITED COA





PRINCIPAL DIMENSIONS.

Length between Perpendiculars, 313'—"
Beam Extreme, ... 42' 1½"
Mean Draught, ... 18' 2½"
Load Displacement in Tons, . . . 3500
Maximum I. H. P., ... 9700
Maximum Speed in Knots, . . . 20½



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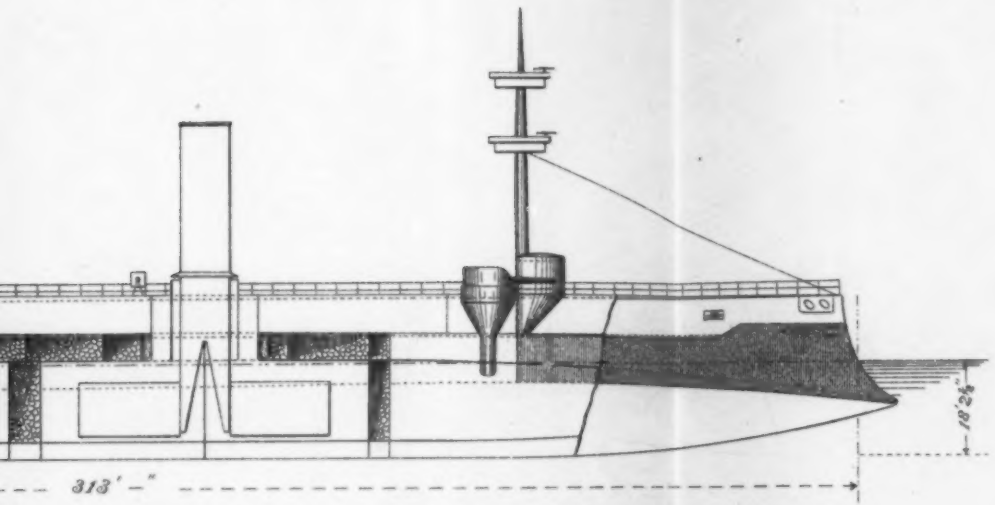

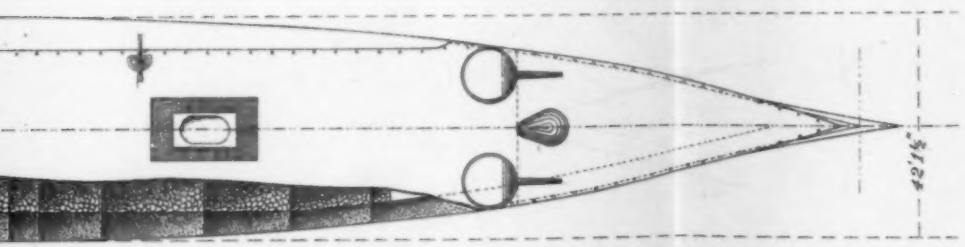

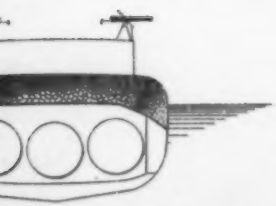

ARMAMENT.

4—5 *inch R. F. G.*
4—6 *pounder R. F. G.*
4—1 *pounder R. F. G.*
3—37 *mm. R. C.*
2—*Torpedo Tubes.*

EDEMWALD, PHOTO LITH. BALTO.

tively well protected and handled independently of the conning tower, is believed to afford adequate return under all circumstances, if only in reducing the enemy's small-gun fire and attacking the unprotected water-line.

Again, in any such vessel it will be evident that the conditions are peculiarly favorable to high efficiency of bow torpedo-tubes, while there seems no valid reason why their presence and use should disconcert the main attack, while it is believed that it may often render it unnecessary and yet more frequently afford favorable conditions. In any case, if they are found to be confusing to the conning tower, they can be served independently of it. Provision must be made for all crews of independent weapons to keep a good lookout and signal to those engaged in their service below to prepare themselves for the shock in time.

Above all it should be noted that, however fine a weapon of this character, the result is peculiarly dependent on the human element in the conning tower.

A design has been prepared which it is believed fulfills the conditions laid down. On a displacement of 3500 tons, a speed of 20½ knots is combined with capacity to turn considerably quicker and in less space than any suitable antagonist. The gun-power is confined to rapid-fire guns entirely abaft the conning tower, but with good command ahead, the larger caliber being in well protected positions. Bow torpedo-tubes are fitted under the protection of the bow armor. The arrangement of protective material is novel and satisfactory against a single enemy, as alone it is possible to make it in such a vessel, but offers fair resistance from all quarters. The light draught renders the vessel peculiarly serviceable in harbor and coast defense, and in the attack by surprise of vessels in port. By suitably arranging the coal stowage the same vessels may form part of a squadron of limited endurance as well as acting in local defense, the increased displacement due to the greater average coal supply still admitting of excellent qualities for the purpose intended; only, when acting within a very limited area, the specially valuable qualities of speed and handiness are improved by loading coal to 300 tons only, stowed entirely above the armor-deck.

RAM OF 3500 TONS.

Principal Dimensions, etc.

Length over all	330′ 0″
Length on load water-line	321′ 6″
Length between perpendiculars	313′ 0″
Beam extreme	42′ 1½″
Mean draught	18′ 2½″
Displacement in tons	3500
Free-board to top of main-deck plank at side	5′ 0″
Free-board to top of poop and forecastle plank at side	12′ 0″
Maximum indicated horse-power (forced draught)	9700
Maximum speed in knots	20¼
Estimated metacentric height	5′ 0″

HULL AND ITS PROTECTION.

To have a double bottom and as great subdivision as possible, especially forward. The engines to be in four compartments and boilers in three.

The poop and forecastle to extend about 80 feet and be connected by a central parallel-sided superstructure about 30 feet wide.

For a length of 70 feet forward, protection will be afforded by side armor of 4 inches, worked on heavy Z frames with an inner mantlet of 15 pounds. The armor to extend from 4 feet 9 inches above the load water-line to the line of armor-deck, which slopes down to the spur, and throughout the length of this armor will be 2 inches thick on the slopes and 1½ inches on the crown. The lower plates on side next the spur to be 1½ inches thick. The main deck over the armor will be plated with a wide stringer of 40 pounds and the remainder of 30 pounds. The side armor will terminate in a 3-inch bulkhead extending from armor to main deck. A belt of water-excluding material 4 feet wide to extend from this bulkhead to the bow, and between the longitudinal bulkheads of this belt shall be arranged the chain lockers, fresh-water tanks (built in), cable tiers, wet provisions, and in the bows, the torpedo room.

Abaft the armor bulkhead the protection to be continued by an armor-deck, with double-side slopes of 22 and 36 degrees, to be 2 inches thick on the crown and 3½ inches on the slopes. Over boilers amidships the crown of this deck to be about 6 inches above the load water-line, and over the engines, about 15 inches.

Depth below water at sides amidships to be about 4 feet 6 inches, ranging to about 3 feet 6 inches towards the ends until it begins to slope down to the spur. A splinter jacket of 10 pounds to be worked

on the under side of the beams of this deck between the longitudinal wing bulkheads.

A belt of water-excluding material about 4 feet 6 inches thick amidships and about 4 feet towards the ends, to extend from armor to berth deck.

Glacis of 3 inches inclined at 30 degrees to be worked to hatches in the armor-deck. Shell-proof gratings to be worked in addition.

CONNING TOWER.

A conning tower to be carried above the forecastle-deck in the middle line. To be pear-shaped in plan. The face, a circular arc of rather more than 180 degrees to an inner diameter of 6 feet, plated 12 inches. The rear an arc of rather less than 180 degrees to an inner diameter of 3 feet, plated 3 inches. Straight sides of 6 inches joining the face and rear. Thicknesses to be joined by tapering the greater thickness into the less across the joint. Height of armor, 5 feet 3 inches. Thickness of crown, 1½ inches; of floor, three-fourths of an inch. To be supported by a cone tube 2 inches thick to main deck, the vertex being in axis of rear circle of tower, which also forms a portion of the foremast. Below the main deck to be continued to the protective deck by a 1-inch tube, and further supported by two radial belt frames under the cone. To be lightly connected at the decks by a ring of plating and light brackets.

ARMAMENT AND ITS PROTECTION.

The battery to consist of four 5-inch rapid-firing guns, four 6-pounder rapid-firing guns, four 1-pounder rapid-firing guns, and three 37-millimeter revolving cannon.

The 5-inch guns to be mounted, two on the forecastle and two on the poop, as shown, in partial barbettes, with shields on the gun and cone protection underneath. Barbettes and shields to be 4 inches or its equivalent, and cone and tube protection, 2 and 1½ inches. The smaller guns to be mounted as shown, with the protection of extra side-plating and heavy shields.

The ammunition allowances are as below:

	Rounds.
For each 5-inch rapid-firing gun	115
For each 6-pounder rapid-firing gun	300
For each 1-pounder rapid-firing gun	500
For each 37-millimeter revolving cannon	1000

TORPEDO OUTFIT.

To have two fixed bow tubes diverging, with the angle between them 5 degrees, and working simultaneously as one weapon.

MOTIVE POWER.

Boilers.—Under forced draught to supply steam of 160 pounds pressure for main engines and auxiliaries. The main boilers to be eight in number, and of the long, low, three-furnace type. Three of them to be 10 feet 9 inches in diameter and 19 feet long. Five of them, 10 feet 6 inches in diameter and 19 feet long. The boilers arranged fore and aft in three water-tight compartments, with two boilers in the forward boiler-room. Aggregate heating surface of main boilers to be 17,500 square feet, and the corresponding indicated horse-power, 9700.

Engines.—The main engines to be four in number, two on each shaft, and of the vertical, triple-expansion, three-cylinder type. The cylinders to be 24¾, 36½, and 55 inches in diameter respectively, and the stroke, 33 inches. The revolutions corresponding to the proposed maximum speed of 20.25 knots to be one hundred and forty-nine per minute, when it is expected that the main engines will develop about 9700 indicated horse-power. The piston speed at the proposed maximum revolutions will be 820 feet per minute.

COAL ENDURANCE.

The coal supply at load draught is 200 tons, and the total coal capacity is estimated at 500 tons. On the coal at load draught the steaming distance at 10 knots is 2000 miles. On the total coal capacity the steaming distance at 10 knots is 4800 miles. At the full sea speed of 19.1 knots the steaming distance on the total coal capacity is 1100. When acting in harbor or other local defense, 300 tons of coal stowed entirely above the deck is to be considered her maximum coal supply, the corresponding endurance being 3000 miles at 10 knots.

ASSIGNMENT OF WEIGHTS.

	Tons.	
Hull and fittings, with conning tower (28)		1338
Hull protection:		
4 inches side, 3 inches bulkhead	105	
Armor deck and glacis	515	
Water-excluding material	120	
		740
Armament, ammunition, and protection		177
Machinery, stores, and spare parts		865
Coal at load displacement		200
Equipment		190
Total		3510

ESTIMATED COST.

Hull and protection	$1,135,050
Machinery	568,830
Ordnance	113,300
Equipment	54,000
Total	$1,871,180

Very respectfully,

W. P. McCANN,
Commodore U. S. Navy, President of Board.

R. L. PHYTHIAN,
Captain U. S. Navy, member.

W. T. SAMPSON,
Captain U. S. Navy, member.

WM. M. FOLGER,
Commander U. S. Navy, member.

WILLARD H. BROWNSON,
Lieutenant-Commander U. S. Navy, member.

R. GATEWOOD,
Naval Constructor U. S. Navy, member.

PHILIP R. ALGER,
Ensign U. S. Navy, Recorder of Board.

Hon. B. F. TRACY, *Secretary of the Navy.*

APPENDIX A.

ORDERS CONSTITUTING THE BOARD.

NAVY DEPARTMENT, *Washington, July* 16, 1889.

SIR: You are appointed president of a Board which will consider and report as to the policy which should be pursued by this Department in the construction of a fleet to meet the future wants of the United States:

(1) How many years should be allowed for the building of the fleet.

(2) What should be the number of vessels of which the fleet should be composed when completed, both for cruising and for coast-defense purposes.

(3) What classes of vessels should be built both for cruising and coast-defense purposes.

(4) What should be the size and general features of each class of vessels.

(5) What proportion of the entire fleet projected should be constructed annually.

(6) What additional percentage should be constructed annually.

(7) What number and classes of vessels should be asked for at the coming session of Congress.

(8) What will be the annual cost of construction and the aggregate cost of the fleet as recommended.

This Board will consist of yourself as president, and of Captains R. L. Phythian and W. T. Sampson, Commander W. M. Folger, and Lieutenant-Commander W. H. Brownson as members, and will convene at the Navy Department on the 23d instant.

You are authorized to call upon the bureaux of the Department for any information or assistance which you may require.

Very respectfully, B. F. TRACY,
Secretary of the Navy.

Commodore W. P. MCCANN, U. S. Navy,
Commandant Navy Yard, Boston, Mass.

NAVY DEPARTMENT, *Washington, August* 5, 1889.

SIR: In addition to your present duties you will report by letter to Commodore W. P. McCann for duty as a member of the Board of which he is president, organized for the purpose of considering and reporting as to the policy which should be pursued by this Department in the construction of a fleet to meet the future wants of the United States. When notified by that officer, you will proceed to Washington and report to him in person for the duty.

Very respectfully, B. F. TRACY,
Secretary of the Navy.

Naval Constructor RICHARD GATEWOOD, U. S. Navy,
Newport, R. I.

APPENDIX B.

INVESTIGATION OF THE MONITOR TYPE.

In a vessel of low speed and very small free-board, such as the monitor as employed during the civil war, it is evident that a greater portion of the displacement can be assigned to armor and armament than in a vessel of comparatively high speed and free-board, though the advantage in this respect is somewhat reduced by the necessity of protecting by armor certain openings, such as smoke-pipe and ventilating hatches, in the absence of other provision against swash as afforded by the sides and subdivision of high-sided ships above the armor deck.

Some incidental advantage accompanies the small target afforded by the low free-board and gun positions, but this has been very much exaggerated in many minds, since damage in the higher unarmored parts of other well-designed armored ships is of little consequence to the vital qualities of the ships, except incidentally, as producing the risk of jamming turret or barbette guns by the explosion of shells within it. The greater target of higher armored parts is more than offset by the greater command of guns, etc., so afforded.

As the speed approaches that of the high-sided ships, the excess of weight available for increased armor and armament diminishes, from the greater fineness of form required. But with the very low free-board, a limit to speed, even in smooth water, is soon reached when the disturbance created by the vessel comes aboard, requiring a considerable fraction of the velocity of the ship to be imparted to considerable masses of water. Thus, such a vessel may not be driven even in smooth water to the same extent as a high-sided ship, and less power may be advantageously exerted in a form of given fineness. No experience of this character exists, but it may be anticipated, especially in the 4000-ton monitor of comparatively high power now under construction for the navy.

This disadvantage of the low free-board type becomes rapidly more pronounced as the water becomes rougher, and especially with the short seas of moderate weather and the choppy seas of large bays.

The low sides of the monitor render necessary enormous stiffness or metacentric height in order to insure even the small range of stability commonly necessary in a sea-way, and, deriving no advantage from the subdivision and presence of water-excluding materials, such as fuel, commonly found in the wings above the armor decks of high-sided ships, any water-line damage is of greater importance as affecting stability and reserve buoyancy. This consideration, together with the great effect of a moderate change of trim on the speed, renders necessary a longer belt of greater thickness, and discounts a portion of the apparent advantage in this respect in existing vessels of this type. Were, however, the monitor so large as to be able to carry armor completely proof against existing guns—as it may be pointed out was practically the case during the civil war—these considerations would not obtain at all, and it will be evident that the advantage of the type in this respect increases rapidly with increasing thickness of armor on a complete or very long belt, or, what is practically the same thing, with the size of the vessel.

The monitor, then, is found to possess valuable qualities where the requirements are smooth water, low speed, light draught, and great heavy-gun fire opposed to the attack of guns not overmatching the armor protection carried in the long or complete belt; and, within the limits of draught permissible for the work, these advantages increase rapidly with increasing size.

Opposed to the fire of guns overmatching her armor, the monitor can stand very little punishment. In a sea-way she has not speed enough to force a combat with any intact ship. But the great and cardinal defect of the monitor type in anything but smooth water remains to be stated, as consisting in the utter lack of steadiness accompanying the great stiffness required for stability and the consequent impossibility of doing any work with the guns. All ships have great stiffness in the direction of their length, and therefore closely follow the effective wave slope in pitching, this slope being, however, very much reduced by the considerable length of most ships as compared with that of all ordinary waves. On account of the great transverse stability of the monitor type, the same conditions obtain in their rolling as in all pitching, except that the beam and draught being small, the effective wave slope is very much steeper. These vessels in rolling, then, closely follow the wave slope, and in such a ship in the trough of waves having a period of eight seconds and a maximum slope of 10 degrees—very ordinary

values—guns trained on the broadside would point at intervals of four seconds from 10 degrees above the horizon to 10 degrees below it. Ordinary vessels roll through larger angles, albeit in a greater time, but they undergo periods of comparative quiet when a gun can be laid with some degree of accuracy.

The monitor's artillery suffers the additional disadvantage of being so close to the water that it is only well up a fair-sized wave that another vessel can be seen, while the swash of water over the decks seriously interferes with the working of common turrets, although it will be observed that from so closely following the water surface much better weather is made than would at first be expected from the extreme lowness of free-board. For the same reason, the effective force on a person aboard being at each instant normal to the wave slope, the motion is much less apparent than in ordinary vessels, and a common short pendulum tending to set itself at right angles to the wave slope gives no indication of the motion of the ship with respect to the true vertical, so that the true roll of these vessels has been overlooked.

The surprise consequent on the comparatively good weather made by monitors in riding out heavy gales and afterwards in long voyages, and the very good work done by them in the attack of fortifications under conditions approaching those of their maximum efficiency, caused a reaction in naval opinion, originally unfavorable, until extravagant opinions were even expressed of their efficiency as cruisers for work on the high seas.

Under certain conditions of the attack and defense of harbors, the Board recognizes real advantages in the type. But it has no efficiency in protecting the coast and commerce from without the harbors, which, in the opinion of the Board, is the chief naval problem. Being further incapable of rapid mobilization and concentration under all conditions of weather, coast-defense by ships of this type would really amount to local defense of the principal harbors, when the enemy had been allowed, by the absence or defeat of our fleets on the high seas, to invest them.

That the same measure of defense can be obtained by very numerous and powerful sea-going fleets off the coast supplemented by monitor and shore defenses of the principal harbors, as with the vessels proposed by the Board, is unquestionable, but we are of opinion that greater security, with far greater economy, can be obtained by the type of battle-ships of limited endurance, capable not only of

affording local defense to the harbors, but of rapid mobilization and concentration under all circumstances, and of acting with perfect confidence on the high seas.

In the opinion of the Board, the six vessels of the monitor type already provided for afford a sufficient proportion of purely harbor-defense vessels.